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AUTOMOTIVE and AVIATION INDUSTRIES

Published on the first and 15th of the month

February 1, 1945
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Playthings for Politicians

by Julian Chase

IN THESE days of publishing difficulties and fast moving events, much can happen between the writing and the reading of such a piece as this. Before these words appear in print, the Senate may have approved the appointment of Henry Wallace as the head of a curtailed Department of Commerce. Some such action may be taken because Senatorial precedent discourages a deeply searching consideration of the adequacy of unmixed cabinet appointments and encourages a more or less casual acceptance of them. Comment here, therefore, with respect to this appalling development concerns itself chiefly with conditions and circumstances deleterious to our national well-being which brought this thing about.

In the matter of Henry Wallace, regardless of how it goes, we have a clear indication that in the Fourth New Deal, again, considerations of party politics will take precedence over fitness and competence in the selection of administration personnel. "Henry Wallace deserves almost any service which he believes he can satisfactorily perform," said the President in unwittingly disclosing words, because in the recent campaign "he displayed the utmost devotion to our cause, traveling almost incessantly and working for the success of the ticket . . . he gave his utmost to the victory which ensued." It would be interesting to know, incidentally, what the first "almost" excludes besides the vice-presidency.

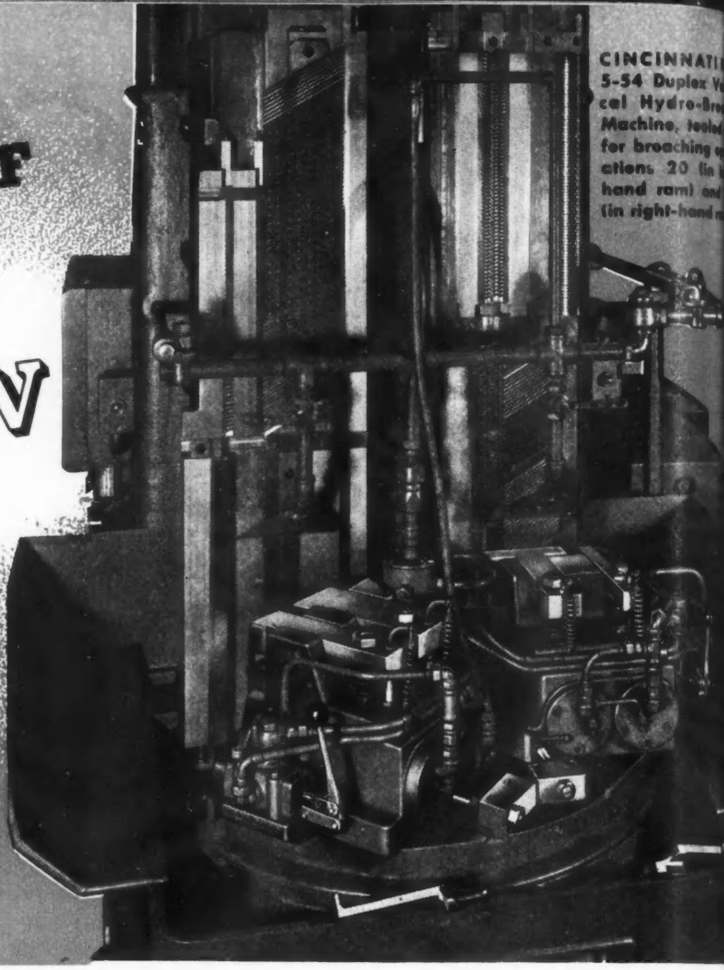
Has Henry Wallace ever in his life demonstrated qualifications for the job based on successful experience in business and finance? Has he shown anything more than a superficial understanding of the problems of business or even a comprehension of what those problems might be? Did he ever, before his appointment, display a sympathetic attitude toward industry? He has most certainly indulged in wild and indiscriminate condemnation while ranting at industrial bogey-men.

Jesse Jones, with a record topped by thirteen years of widely acclaimed competence in government service, appears to have been riding on the administration plane with a *C* priority. He is now "bumped off" by an *A* rated consignment of political reward taken on to pay off, at public expense, a personal debt to a vice-presidential cast-off. And now this seeming detriment to a fourth-term re-election is tagged for a berth in the administration's haven for lame-ducks in a spot where an eminently qualified man had made good and was willing to continue to serve.

What reassurance is there in all this that the administration's attitude toward industry and the enterprise system has improved of late to the advancement of the general welfare? What evidence is there in it that the administration realizes even dimly the predominant part that inspired and encouraged industry must play in rebuilding and expanding our productive economy? What hint is there that badly needed inspiration and encouragement are at last to supersede badgering and bludgeoning? There is proof that there is still a Herculean task to be performed, by strong men who know, in teaching many of the people and an aged but immature administration that the business of the land is not a plaything for politicians.

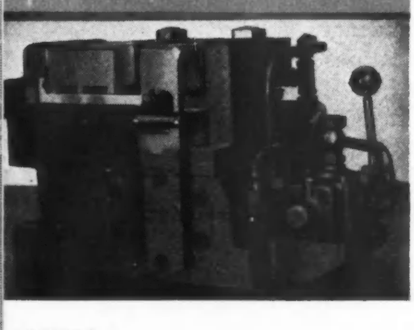
AUTOMOTIVE INDUSTRIES
Reg. U. S. Pat. Off.

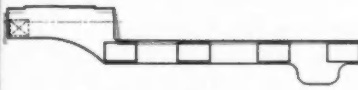
IT TAKES A LOT OF KNOW-HOW TO BROACH PARTS LIKE THESE



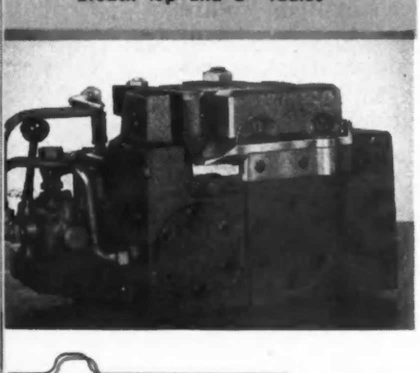
CINCINNATI 5-54 Duplex Ve[rti]cal Hydro-Broa[ch] Machine, tooled for broaching op[er]ations 20 (in l[eft-]hand ram) and (in right-hand r[am])

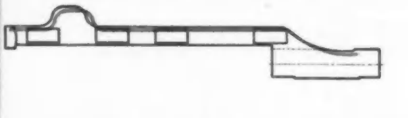
OPERATION 20
Broach bottom and tube section ends





OPERATION 25
Broach top and 2" radius



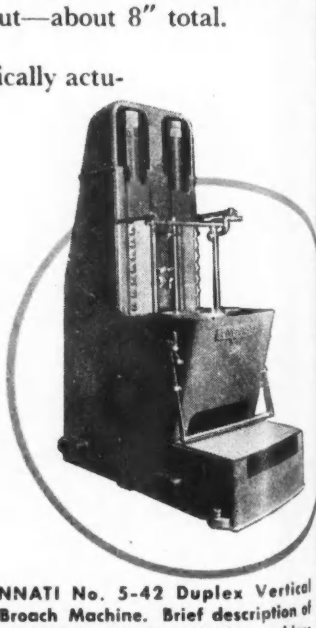


Yes, it takes a lot of know-how, years of practical experience, to tool up a machine for the broaching operations indicated on the long slender parts at the left. And the experience and know-how of CINCINNATI Engineers is available to you in Stepping up production or in obtaining greater over-all operating efficiency through the application of the right machines, fixtures, and broach inserts.

This example shows a CINCINNATI No. 5-54 Duplex Vertical Hydro-Broach, with exceptionally modern tooling, for broaching the surfaces indicated in color to accurate tolerances. Note the wide cut—about 8" total.

Important features of this installation include hydraulically actuated fixtures, with limit switch control to assure proper loading of the part before the ram can descend. Add to this the elaborate broaching inserts and you have an idea of the ability of CINCINNATI Engineers to solve your production problems involving the machining of complex as well as simple parts.

In retooling for quicker victory, it will pay you to consult CINCINNATI. Send blue print of part, indicating sequence of operations and surfaces to be machined. Complete data may be obtained by writing for specification catalog, M-894-2.



CINCINNATI No. 5-42 Duplex Vertical Hydro-Broach Machine. Brief description of these productive and dependable machines may be found in Sweet's Catalog File.

CINCINNATI

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TOOL ROOM AND MANUFACTURING MILLING MACHINES . . . SURFACE BROACHING MACHINES . . . CUTTER SHARPENING MACHINES

Wide Range of

Technical Subjects

at S A E War

Engineering Meeting

By Joseph Geschelin

BEST attended in many years, the 1945 War Engineering-Annual Meeting of the Society of Automotive Engineers held early in January at Detroit was an enormous success in terms of numbers and interest in technical sessions. This record may have an important influence upon the prospects of holding the several Regional Meetings already scheduled for 1945 in the light of the directive issued by War Mobilization Director Byrnes banning conventions of more than 50 people. Analysis of the registrations at this meeting—at technical sessions and committee meetings—will have to be carefully conducted to implement the petition which, doubtless, will be filed in an effort to exempt the SAE from the restrictive directive.

With well over 50 papers on the program, cutting across the interests of every engineering activity of the Society, it would be a formidable task indeed to attempt to summarize the events of the week in a single report. All we can do is to highlight certain sessions which appear to have wide significance. Since space does not permit a summary of every paper, the choice of subjects in this article is not to be construed as an evaluation of the relative merits of the other papers.

As might be expected the internal combustion engine—the heart of automotive equipment of every kind—came in for considerable discussion. C. F. Kettering presented a paper, "Fuels and Engines for Higher Power and Greater Efficiency" which was worthy of the stature of developments stemming from the General Motors Research Laboratories. To our regret, this paper, although distributed as a preprint to everyone at the meeting, was marked "Confidential" and not for publication. However, our readers will find an approach to the same subject in an article "Triptane, a Super Fuel" by C. F. Kettering, published in AUTOMOTIVE AND AVIATION INDUSTRIES, Dec. 1, 1944.

Performance of supercharged aircraft engines during the war has been improved to a remarkable degree by the installation of an alcohol-water injection system. At this meeting the subject was covered exhaustively by A. T. Colwell, R. E. Cummings, and D. E. Anderson of Thompson Products, Inc. Briefly summarized, it is claimed that a 50-50 alcohol-water mixture is the best fluid for most applications. Its effectiveness, which lies in control of pressure rise and shock, facilitate the development of higher compression engines of minimum weight. Best gains are realized when fuel of approximately 12 octane numbers lower than engine requirement is used. The injection system is visualized as having its greatest field for application in light aircraft type engines which may be designed to operate on fuel for ground vehicles after the war. For ground vehicles, the maximum economy will be found on supercharged engines. Another economy is claimed in the possibility of using lower grade fuels, particularly for ground vehicles. The authors believe the injector could be made an integral part of a carburetor.

Operating economy was attacked from another standpoint by F. R. Fageol and Ralph M. Werner, in papers dealing, respectively, with the advantages of multiple power plants in buses and in motor trucks.

On the operating side of the picture, H. C. Mougey discussed piston lacquering, its causes and cure. The problem has been divided into three classes—low temperature, intermediate temperature, and high temperature operation. There is a complex overlapping of the factors involved—operating conditions, suitability of oils and fuels to the engine and to the conditions, etc. Co-operative research is in progress to evaluate these factors and to develop ground rules which may be ap-

(Turn to page 86, please)

Chevrolet Technique in

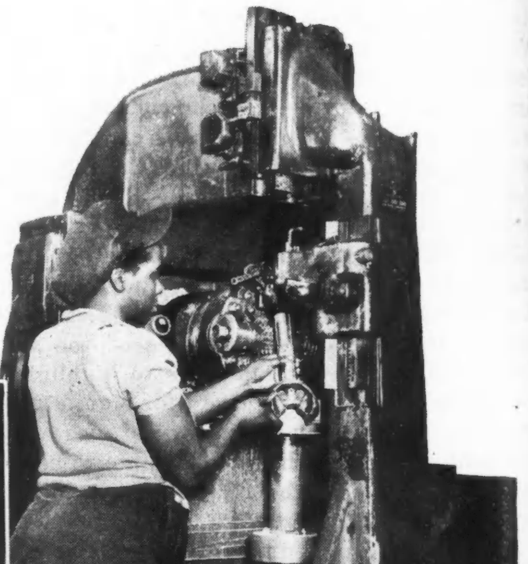
Volume Production of Bendix-Weiss

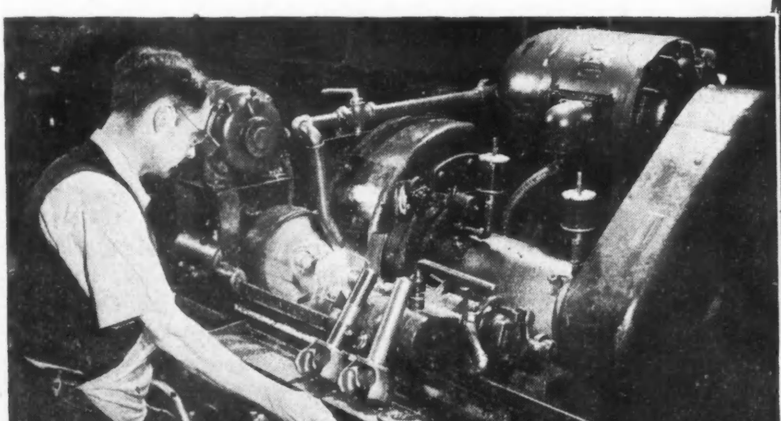
On several occasions in the past this publication has presented material on the design and manufacture of constant-velocity universal joints by the principal commercial suppliers. At this writing it is possible to comment on the role played by Chevrolet in the manufacture of Bendix-Weiss joints under license from the Bendix Aviation Corp.

Chevrolet undertook the manufacture of Bendix-Weiss joints early in the National Defense program—before Pearl Harbor—at a time when it was evident that available manufacturing facilities were insufficient to meet the needs of the Armed Forces. This problem was given to the Chevrolet Gear and Axle Div., General Motors Corp., in February, 1940, with the responsibility for the production of sufficient joints not only for all military vehicles to be made by the Division, but also for approximately half of all joints used by the General Motors Truck and Coach Division in the "Duck." To date they have made over 875,000 joints—about 35 per cent of all constant-velocity joints made in this country.

In approaching the manufacturing problem, the division looked at the task from the standpoint of a gear specialist. It was recognized that the production of forgings could be assured in advance by the "know-how" stemming from many years of experience. The major part of the machining could be done by conventional methods. However, the unique problem was that of machining the four grooves or races for the four balls. These races had to be cut in a true circular path, indexed from one to another with precision, and located accurately from a fixed shoulder.

From the outset Chevrolet decided that the job could be done on a Gleason Gear Generator—a machine possessing ruggedness and inherent accuracy and the ability to carry the cutting tool in a perfectly circular path. Owing to the availability of a large battery of

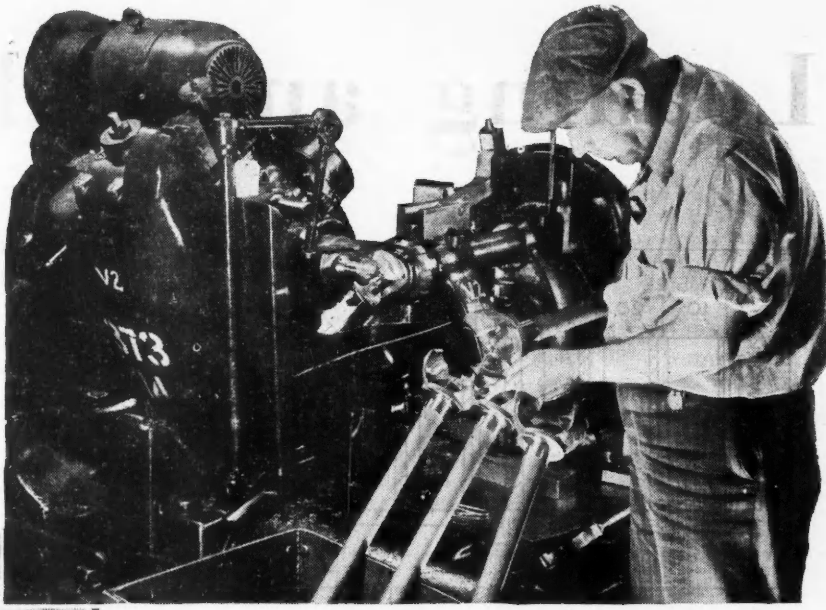


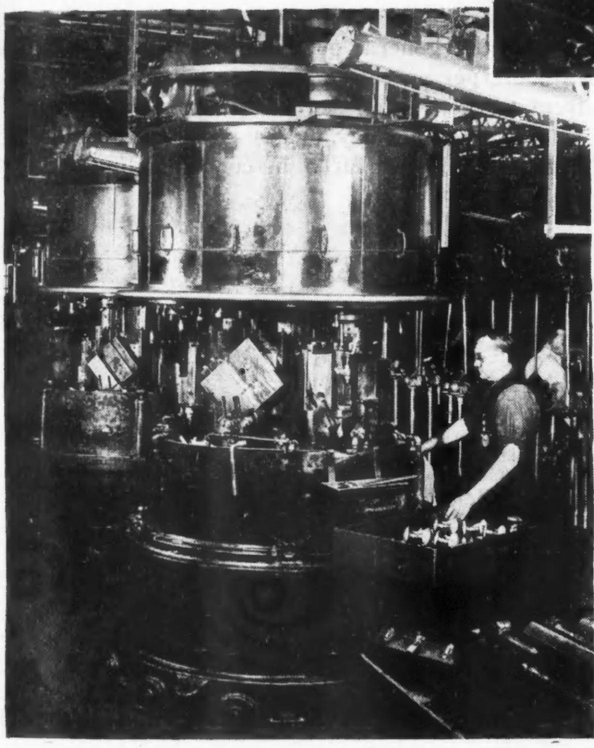


(Above) Splines are cut by hobbing on Cleveland Rigidhobbers, one of which is shown here.

(Left) Splined ends are finish-ground on familiar grinders as shown here.

Joints





(Above) Close-up of one of the converted Gleason generators used for cutting the four races.

(Left) Bullard Mult-Au-Matics are employed for turning the OD, boring the ID, facing and centering of the ball seat.

15-inch Gleason Spiral Bevel Gear Generators, it was decided to convert one of the machines to do the job. The first attempt was so successful that ultimately 40 or more of these machines were thus converted for use on the production line. This Chevrolet innovation was made available to other manufacturers in the industry, thereby breaking a bottleneck that seriously threatened the mass production of military vehicles.

From the standpoint of machine shop routing, the setup for making the joints resolved along relatively simple lines as is evidenced by the following steps in the process:

Normalize.
Straighten.
Center both ends
Rough turn diameter of the entire shaft, except long ones—bearing surfaces adjacent to ball are machined.
Grind splined end.
Cut spline.
Bullard operation on OD, ID, face and center ball seat.
Mill ball race on specially converted Gleason generator.
Heat treat, harden, draw.
Assemble.
Shot blast.
Mill spline end to length

Forging procedure was developed along interesting lines. The job is done on both hammers and upsetters. The outer half of each joint is hammered from $3\frac{1}{4}$ in. RCS stock $5\frac{1}{2}$ in. in length. The billets are sheared, heated to 2200-2250 F, then are given six blows for fullering, one blow for edging, and four blows for finishing. Final operation is trimming of the flash.

The two inner halves of the joints differ in length—one requires $50\frac{1}{2}$ in., the other 40 in. of $1\frac{1}{2}$ in. stock. Of these lengths, 20 in. of stock is consumed in gathering sufficient metal to make up the ball end. These sections are produced in three major operations:

1. Forming the ball end.
2. Forging the ball to form.
3. Gathering stock for the spline end.

To form the ball, $1\frac{1}{2}$ in. stock is sheared to the 40 and $50\frac{1}{2}$ in. lengths which are heated to 2200-2250 F and the ball end gathered in a 5-inch upsetter. A five-impression multiple die is used, the stock being passed once to each station, then allowed to cool.

In the hammer shop the ball end is reheated to 2200-2250 F and worked in a 2500-lb hammer fitted with a two-impression die and a flat surface for edging. The heated ball is struck twice for edging, then receives three blows in the blocking impression, followed by three blows in the finish impression, and is flash-trimmed.

Final operation is that of gathering the spline end. The work is heated and formed in a 4-in. upsetter in three passes. The first shears the work to length, the next two are made in a single die to gather the stock.

The forgings then are ready for transportation to the machine shop for shipment to other manufacturers who are supplied by Chevrolet.

Loading and Scheduling a

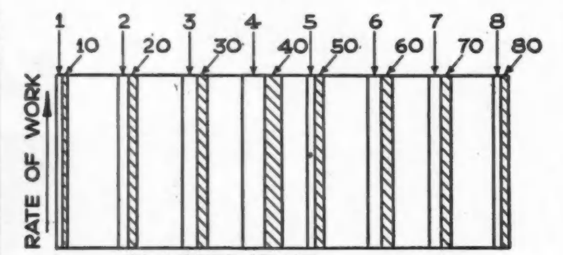


FIG. 1

A NEW method for loading and scheduling a tooling department has been developed by tool engineers of Consolidated Vultee Aircraft Corp. It is based on the following assumptions:

(1) That the load of each section is proportional to the number of "equivalent" engineering dash numbers released from the Product Engineering Department.
(2) That the distribution of this load in each section is approximately triangular.

From this, it may be concluded that the elapsed time for the job within each section is the square root of the load multiplied by a constant for each section.

The method of determining the *"M"* (or manufacturing) day for starting and finishing a job in each section consists of using the capacity of the planning section to determine the daily delivery of tool shop orders to each of the other sections and assuming that the overload in the other sections will be vended. Statistical data are presented on the average number of tools per dash number, the distribution by size of the types of tools classified as "small," "medium" or "large," and the average number of man-hours required for each size of tool; and, from these, the man-hours of planning, design, and tool fabrication per "equivalent" engineering dash number and the elapsed time constant for each section may be computed.

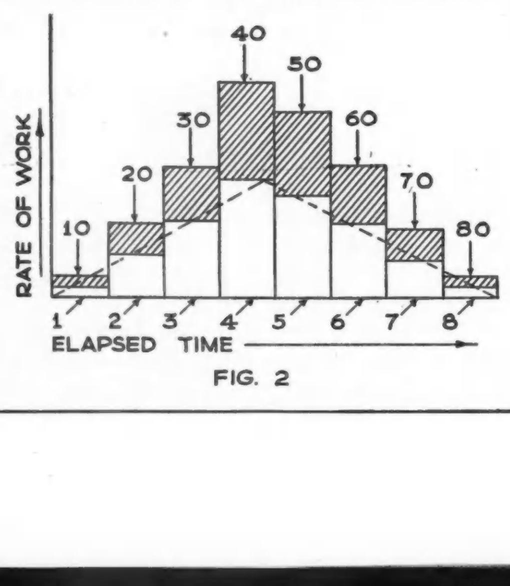


FIG. 2

The statistical data are reduced to formulae which are plotted on log-log paper so that an index line drawn through the value of the "equivalent" engineering dash numbers will produce the man-hours of load and the elapsed time of the job for each section. Another curve, cut by the same index line, will establish the *"M"* day of the tool shop orders and thus determine the *"M"* days of start and finish of the job within each section.

Since each section comprises personnel who individually accomplish specific operations, it becomes possible to utilize the general principle of the application of man-hours per operation as indicated in Fig. 1. The rate of work is expressed as one man-hour per hour, or one man-day per day, or any other convenient unit; elapsed time is measured in corresponding units of hours or days.

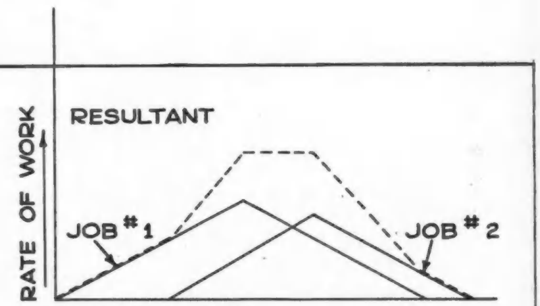


FIG. 3

The rectangle "1" of Fig. 1 represents the action of a clerk who organizes the work for the supervisor of the section. The area of the rectangle is the product of the rate of work multiplied by the time required to complete the action. If the rate of work is one man-hour per hour and the elapsed time is measured in hours, the area "1" is the measurement of the man-hours required to complete that action. When the action is completed, the job is moved into the backlog of the supervisor of the section, who (working at the rate of one man-hour per hour for the hours required to complete the action) applies man-hours to the job as reresented by area "2" of Fig. 1. Similary, the job moves into successive backlogs. The man-hours of a leadman are represented by area "3"; of detail action, by area "4"; of checking action, by area "5"; of proofing, by area "6"; of determining the next action, by area "7"; and of final action to clear the job from the section, by area "8." Areas "10" to "80," respectively, denote the man-hours applied by each operator to a second job coming into the section.

The number of man-hours per action increase and decrease are indicated in Fig. 2, where the broken-

Tooling Department

By N. E. Nylin
Tool Project Engineer
Consolidated Vultee Aircraft Corp.

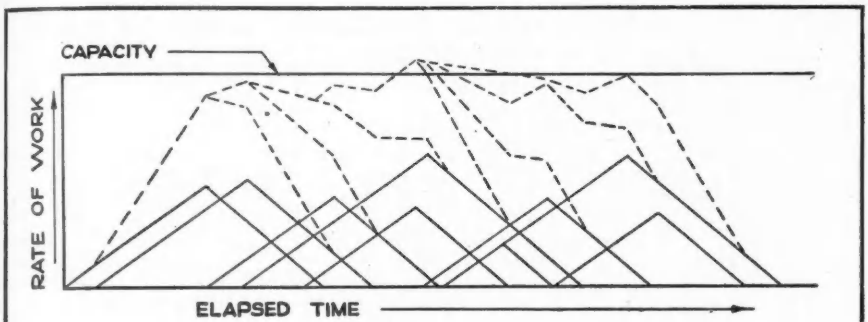


FIG. 4

line triangle circumscribing areas "1" to "8" closely approximates the sum of the areas under it (since those portions outside of the triangle will fill the blank areas within the triangle). Triangles similar to the one in Fig. 2 can be used to represents all jobs, and when they are located with proper relationship to one another they will show the starting and finish "M" dates of successive jobs. Fig. 3 shows two job triangles properly located and indicates how their areas add up so that the resultant (broken) line is the total amount of work at any moment of elapsed time.

As jobs come into each section, the dimensions of the triangle of man-hours can be computed and located with respect to the preceding resultant so that the new resultant will approach the capacity of that section. The addition of several jobs to a section, located so that the resultant approaches a straight line, "hunting" the capacity of the section, is illustrated in Fig. 4. Here the angles at the base of the triangle determine the rate at which man-hours are applied to a job. Theoretically, these can be at any angle; but, practically, they are limited as follows:

(1) If the angle is large, the rate of application of man-hours is fast and jobs will have a very short elapsed time (causing inaccuracy).
(2) If the angle is small, the rate of application of man-hours will be slow and each job will have a long elapsed time (approaching the limit of one person doing the entire job).

Neither extreme will affect the volume of jobs coming from a section, because man-hours per job and total capacity are not thus related to rate of application.

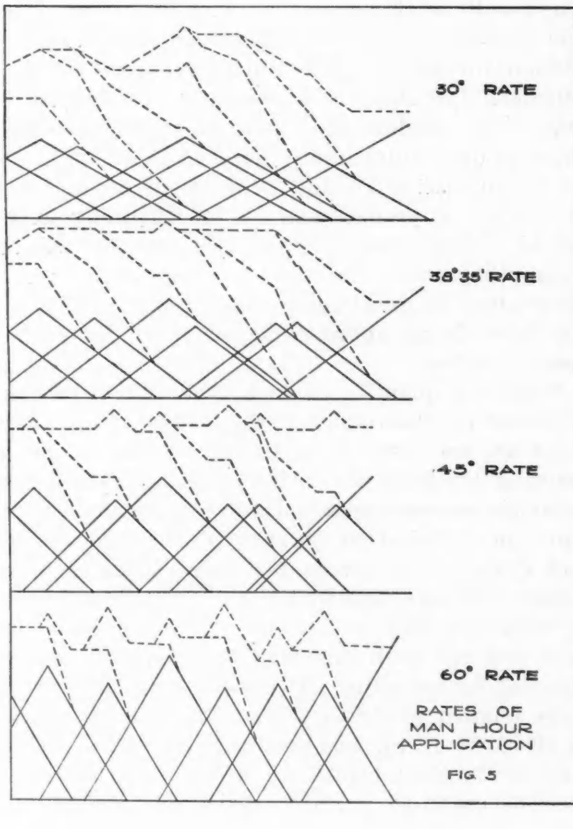
Fig. 5 shows four different rates of aplication of man-hours for the same series of jobs, proving that there is a degree of sensitivity in loading to the capacity of a section. The 30 deg angle and 60 deg angle are difficult to load because of the "rough" resultant, while the 38 deg 35 min. and 45 deg angles are less "lumpy." Accordingly, at Consolidated Vultee, we normally use the angle of 38 deg 35 min. (height of triangle equals 0.40 times base of triangle), because it is the least sensitive of rates of loading.

For computing the man-hours of work for a planning section, it is assumed that the average dash number can be planned in a standard time. This number reflects factors as follows:

(1) In a count of 8065 engineering releases, it was found that 4600 were acceptable for production use; the remainder were replaced with 5900 synthetic assembly numbers for a total of 10,500 production-wise assembly numbers. Therefore, reduced to percentages, each engineering assembly produces 1.30 production assemblies.
(2) An analysis of total tools fabricated over a long period of time shows that 40 per cent of all tool work is due to alterations.

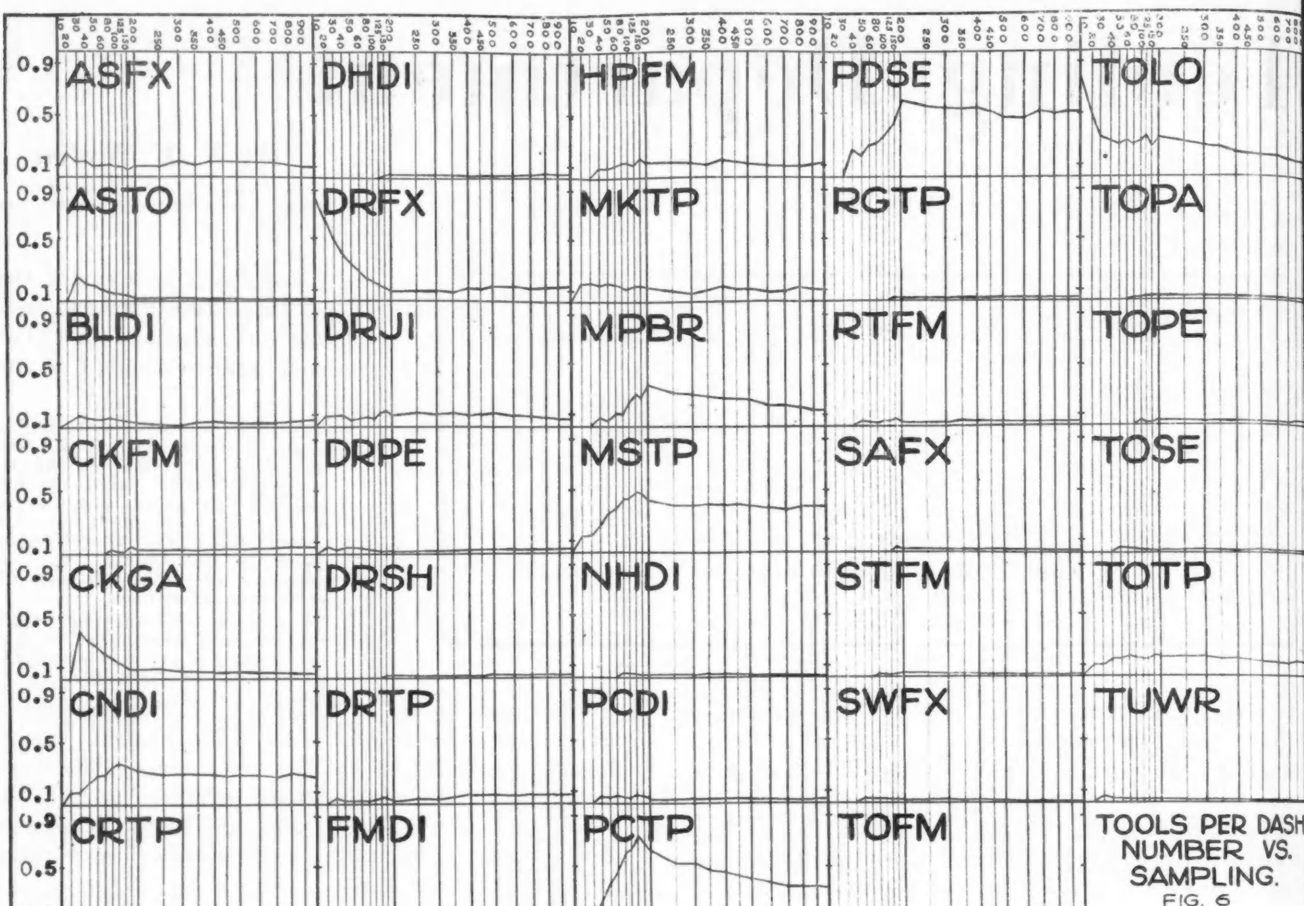
From the above, "equivalent" dash numbers can be ascertained with reference to a job analysis report. The application of corrections and the addition of corrected dash numbers produces what is termed the "equivalent dash number" per job. In the remainder of this article, the term "dash number" will mean "equivalent dash number."

To determine how the load in the planning section affects other tooling department sections, an analysis of the planning section—i. e., of tool shop orders per tool line-ups—was made to establish the number of



RATES OF MAN HOUR APPLICATION

FIG. 5



TOOLS PER DASH NUMBER VS. SAMPLING.
FIG. 6

each type of tool per 1000 dash numbers and how regular the distribution would be for smaller samplings. The results of this analysis are shown in Fig. 6, where the averages of common tools per dash number are plotted for the various samplings chosen. The dash numbers for analysis of successive samplings were selected at random and it can be seen that when 250 or more dash numbers are planned in a day, the loads in the successive Tooling Department sections are almost exactly proportional to the Planning Section's action. This establishes the fact that the successive tooling department section's loading triangles may be determined by multiplying the planning section's loading triangle by appropriate constants for each successive section.

Since the quantity of each type of tool can be determined per dash number, the loads in successive sections are the sum of the design or fabrication manhours of the tools per dash number. It is not easy to ascertain average man-hours per dash number for design and fabrication because of the wide range of tool sizes; so, for more accurate estimates of manhours, tools are defined as small, medium, and large as indicated in Fig. 7. The number of each size of each tool per dash number (tool distribution) is arrived at by analyzing the cutting specifications for a large number of detail parts. Sheet metal blanks up to 12 in. by 12 in., and sections up to 12 in., are considered "small"; blanks up to 36 in. by 48 in., and sections up to 48 in., are considered "medium"; and blanks up to 48 in. by 144 in., and sections 49 in. and longer, are considered "large." Thus we have the following distribution of airplane parts by size:

Small	=	0.666
Medium	=	0.275
Large	=	0.059

This distribution shows that of 1000 templates 666 would be "small," 275 "medium," and 59 "large."

Now, to arrive at a fairly accurate tool design and fabrication man-hour load, it is only necessary to multiply the number of each type of tool per dash number by the distribution factor to determine how many of each size will be expected; and, in turn, to multiply these values by the estimated man-hours of design and fabrication per type and size of tool. The sum of these values will be the average tool design, template, and detail tool fabrication man-hours of load for each dash number planned.

Referring to Fig. 8, we find that the area of the load triangle would represent the man-hours required to do the job:

$$\text{(a)}\quad H = \tfrac{1}{2} \times t \times 0.4t = 0.2t^2$$

where t is elapsed time in hours (rate of work being hours per day), and H is the total number of manhours in the load triangle. To determine H, the number of dash numbers (n) in the job is multiplied by the standard man-hours (M) to complete the job, and divided by loading factor (P):

Fig. 7

Name of Tool	Symbol	Small Tool	Medium Tool	Large Tool
Assembly Fixture	ASFX	Sub-assy. fixture up to 50 in. long. Simple contours, locators, std. or simple clamps or locators and few parts to be assembled.	Sub-assy. fixture up to 17½ ft. long. Contours to be designed. Locators and several parts to be assembled.	Large fuselage or wing fixture up to approx. 50 ft. long. Many contours complicated structure. Many complicated clamps and locators.
Blanking Die	BLDI	Blank small size parts up to 1 ft. square.	Blank medium size parts 1 x 1 to 3 x 4 ft.	Blank large parts from 3 x 4 ft. to 4 x 10 ft.
Checking Gage	CKGA	Up to 22 in. long. Few checking devices, simple design, straight lines, and single contour. No other tools affected.	From 22 to 72 in. long. Moderate no. of checking devices, single angles, simple contours. Part to be checked easily accessible. Coordination with other tools.	From 72 to 210 in. long. Many locators or checking devices, close tolerance, compound angles and contours. Accessibility to part to be checked. Complicated fixture. Coordinate with other tools.

(b) $H = \dfrac{Mn}{P}$

Equating (a) and (b): (c) $0.2t^2 = \dfrac{Mn}{P}$

The elapsed time, in hours, to complete the job is:

$$\text{(d)}\quad t = \sqrt{\frac{Mn}{P}}\ \sqrt{\frac{1}{0.2}} = 2.235\sqrt{\frac{Mn}{P}}$$

It is desirable to express time in elapsed days ($t = 8T$, where T is time in days) and to use an 80 per cent loading factor throughout. Accordingly:

$$\text{(e)}\quad T = \frac{2.235}{8}\sqrt{\frac{1}{.80}}\ \sqrt{Mn} = 0.312\sqrt{Mn}$$

Equation (e) demonstrates that the elapsed time for completion of any job is a constant times the square root of the standard man-hours involved in the job. This may further be reduced for convenience:

$$\text{(f)}\quad T = 0.312\sqrt{M}\ \sqrt{n}$$

Here M for each section, other than planning was computed as M_T, $M_D + M_a$, M_f and M_A.

Over a period of time, and at 80 per cent loading, it was determined that a tool planner required 1.0000 man-hours to plan an "equivalent" dash number, while other personnel of planning applied man-hours in the ratio of *personnel of a function* to *personnel of tool planning function.*

Accordingly, the distribution of man-hours per planning function was as follows:

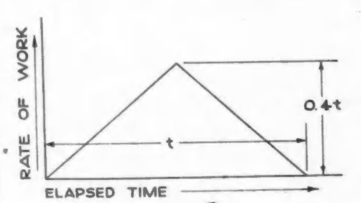


FIG. 8

			Man-hours per dash No.		
Make or Buy Group					
Clerk	=	2	.0465		
Production Planner	=	3	.0697		
				.1162	
Tool Planning Group					
Clerk	=	28	.6510		
Ass't Supervisor	=	9	.2061		
Tool Planners	=	43	1.0000		
Mfg. Checkers	=	8	.1861		
Operation Planners	=	16	.3719		
Spares Planners	=	12	.2790		
Time Study	=	7	.1625		
				2.8566	
Line Stationing Group					
Clerk	=	3	.0697		
Production Planner	=	8	.1861		
				.2588	
Audit Group					
Clerk	=	3	.0697		
Auditors	=	8	.1861		
				.2558	
					3.4844

The following M's were obtained from above:

Make or Buy	(M_b) =	.1162 man-hours per dash number
Tool and Operation Planning	(M_t) =	2.8566 man-hours per dash number
Line Stationing	(M_l) =	.2558 man-hours per dash number
Auditing	(M_a) =	.2558 man-hours per dash number
Complete Planning	(M_p) =	3.4844 man-hours per dash number

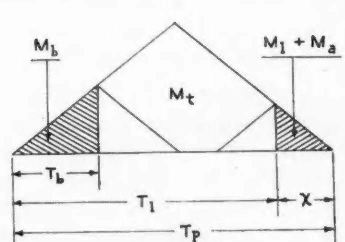
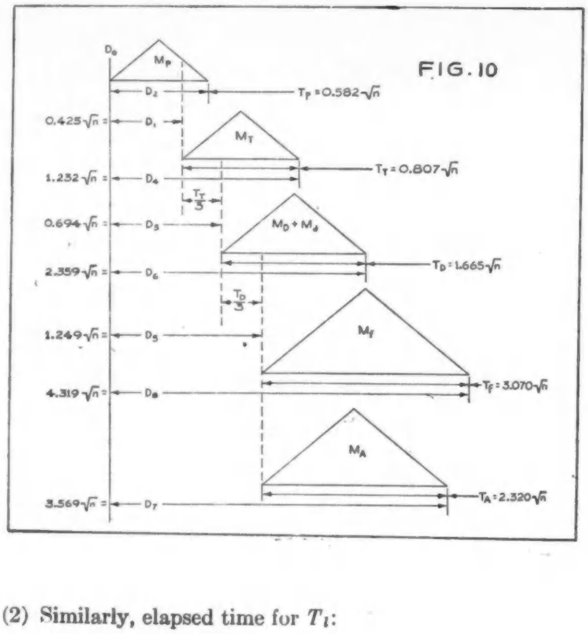


FIG. 9

It is desirable to know the time a job should remain in a function; so, referring to Fig. 9, the following equations may be developed:

(1) Elasped time for M_b, from the geometry of the similar triangles of $2M_b$ and M_p:

$$\frac{2M_b}{(2T_b)^2} = \frac{M_p}{T_p^2}\quad T_b = 0.128T_p$$



(2) Similarly, elapsed time for T_l:

$$x = 0.271\, T_p$$
$$T_l = T_p - x = T_p - 0.271\, T_p$$
$$T_l = 0.729 T_p$$

(3) Therefore:

$$T_p = 0.312 \times \sqrt{3.4844}\ \sqrt{n}$$

$$T_b = 0.582\sqrt{n}$$

$$T_b = 0.128\, T_p = 0.128 \times 0.582\sqrt{n}$$

$$= 0.0746\sqrt{n}$$

$$T_l = 0.729\, T_p = 0.729 \times 0.582\sqrt{n}$$

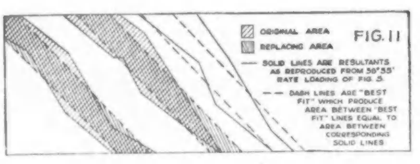
$$= 0.425\sqrt{n}$$

Fig. 10 establishes the relationships between the several tooling department sections. The value of the elapsed times were determined by adding 15 per cent to the *M's* to account for indirect labor, and substituting these values in the equation:

$$T = 0.312\sqrt{M}\ \sqrt{n}$$

The offsets $\frac{T_T}{3}$ and $\frac{T_D}{3}$ are arbitrary, but generally they reflect the order in which the tools are manufactured. Strictly speaking, a number of tools requiring no design can be started as soon as tool shop orders are available, but the longer manufacturing dates are in order because of the requirement of vending tools. The "*D*" dates are scheduling days for each section's activities; they are determined from the geometry of the relationships:

The D_O date is forwarded from the general release group of tooling:



$$D_1 = T_1 = 0.425\sqrt{n}$$

$$D_2 = T_p = 0.582\sqrt{n}$$

$$D_3 = D_1 + \frac{T_T}{3} = 0.425\sqrt{n} + \frac{0.807\sqrt{n}}{3} = 0.694\sqrt{n}$$

$$D_4 = D_1 + T_T = 0.425\sqrt{n} + 0.807\sqrt{n} = 1.232\sqrt{n}$$

$$D_5 = D_3 + \frac{T_D}{3} = 0.694\sqrt{n} + \frac{1.665}{3}\sqrt{n} = 1.249\sqrt{n}$$

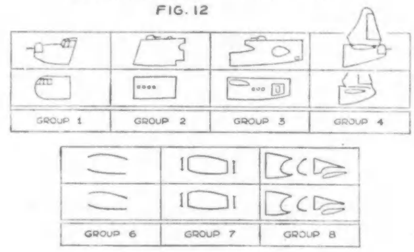
$$D_6 = D_3 + T_D = 0.694\sqrt{n} + 1.665\sqrt{n} = 2.359\sqrt{n}$$

$$D_7 = D_5 + T_A = 1.249\sqrt{n} + 2.320\sqrt{n} = 3.569\sqrt{n}$$

$$D_8 = D_5 + T_f = 1.249\sqrt{n} + 3.070\sqrt{n} = 4.319\sqrt{n}$$

Referring again to Fig. 5, we find that the loading to a given capacity is based on the principle of replacing the load triangle with an approximate parallelogram of equal area so that the top of the parallelogram "hunts" the capacity. The broken dash line comprising the approximate 45 deg resultants may in turn be replaced with a "best line" which in reality is the locus of the empirical equation which best "fits" a collection of points lying on an approximate straight line.

SEGMENTS OF THE SHIP
FIG. 12



An analysis of the slopes of the "best lines" as computed by a standard procedure (*Graphical and Mechanical Computation,* Lipka) indicates that the slopes of the "fits" are all of the same magnitude and the deviation from average is in the order of 1 deg 45 min.

To determine the elapsed time between completion "*M*" days of two jobs, the load triangle area is converted into a parallelogram of the same area, with an altitude equal to the man-hours per day capacity of the department (see Fig. 11). Arithmetically, the man-hours of load divided by the man-hour capacity per day gives the elapsed days between finish dates of the last and latest jobs. If "*C*" is planning capacity in man-hours per day and "*D*" is elapsed days between completion of last job and the new job being loaded in, then:

$$D = \frac{M_p n}{C}$$

The replacing parallelograms do not always give the same "*D*" as will the resultants, but they very rapidly readjust the dates as successive jobs are applied and will always give the "*D*" which exactly loads to the

(*Turn to page 42, please*)

Bristol

Short-Range Low-Speed

Freighter

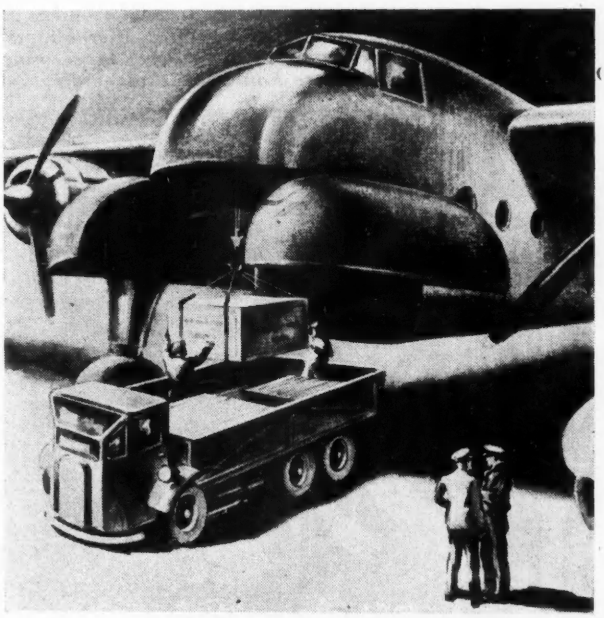
THE Bristol Aeroplane Co., the British concern responsible for the development of the single sleeve valve for aircraft engines, as well as manufacturing various types of aircraft, is building the prototype of a specialized freighter, which is expected to be ready for its trials next summer and to be put into production before the end of the year.

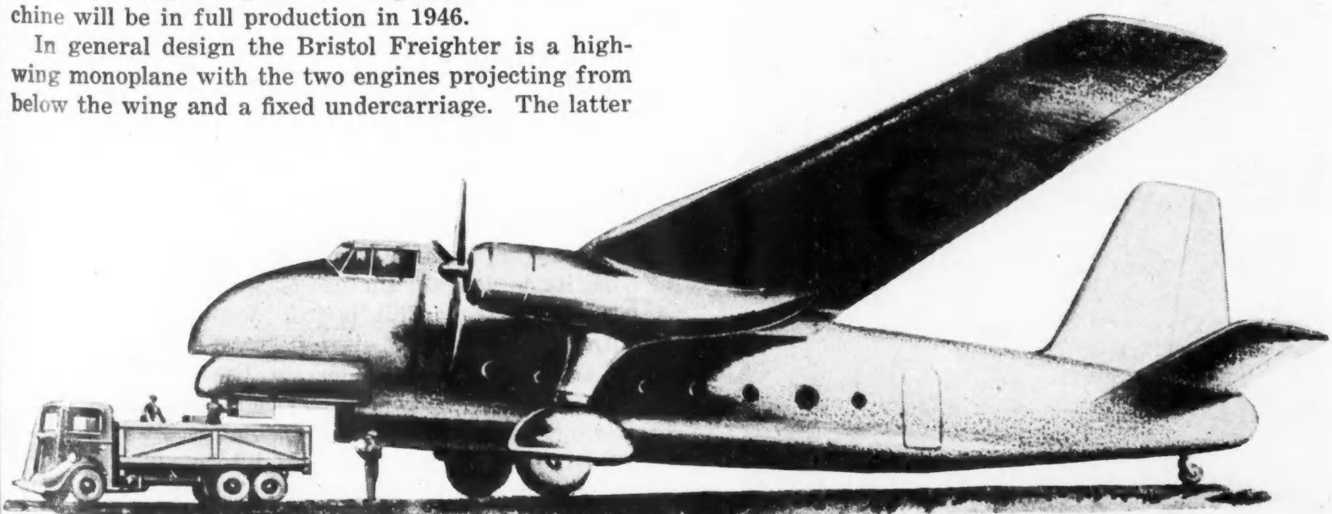
Initially, it will have a gross weight of 27,500 lb and a disposable load of 10,000 lb. For a range of 300 miles the payload will be 9000 lb, and it is claimed that where the load factor and the intensity of use are reasonable the operating cost will be one shilling (say 12-14 cents) per long-ton-mile.

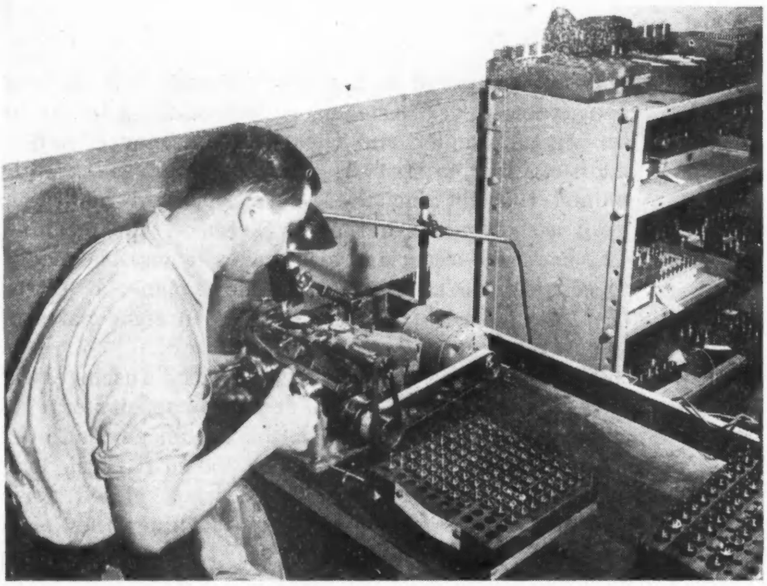
To secure this operating economy a low cruising speed is planned. Since this machine is to be used exclusively for freight transport, no accommodation for passengers will be provided in the Bristol Freighter, as it will be known. It is designed, therefore, to have a cruising speed of 120-150 mph, powered by two Bristol Perseus nine-cylinder air-cooled sleeve valve engines of about 1000 hp each, giving a power loading of around 14 lb hp. A similar but more powerful engine is being developed for use where take-off requirements can be met at a higher gross weight (30,500 lb) and correspondingly greater payload. With this larger engine it is expected that the machine will be in full production in 1946.

In general design the Bristol Freighter is a high-wing monoplane with the two engines projecting from below the wing and a fixed undercarriage. The latter may be considered as a retrograde step, but the non-retractable undercarriage has been adopted in the interests of simpler and cheaper maintenance, and is additionally justified by the reduction in weight gained thereby and the relatively slight additional drag associated with the low speed of the machine. The fixed undercarriage also makes it possible readily to convert the machine into a float plane, a version that may be required by operators in some parts of the world.

The freight compartment within the fuselage will have a floor space of 210 sq ft and a capacity of 1700 cu ft, enabling it to carry the maximum payload even with items of freight as bulky as 350 cu ft to the long ton. The freight-loading doors when closed form the lower half of the nose of the machine; they open downward on longitudinal hinges. The top half of the nose, below the floor of the pilot's compartment, supports an overhead rail with hoist for lifting freight inboard and carrying it to any part of the interior.

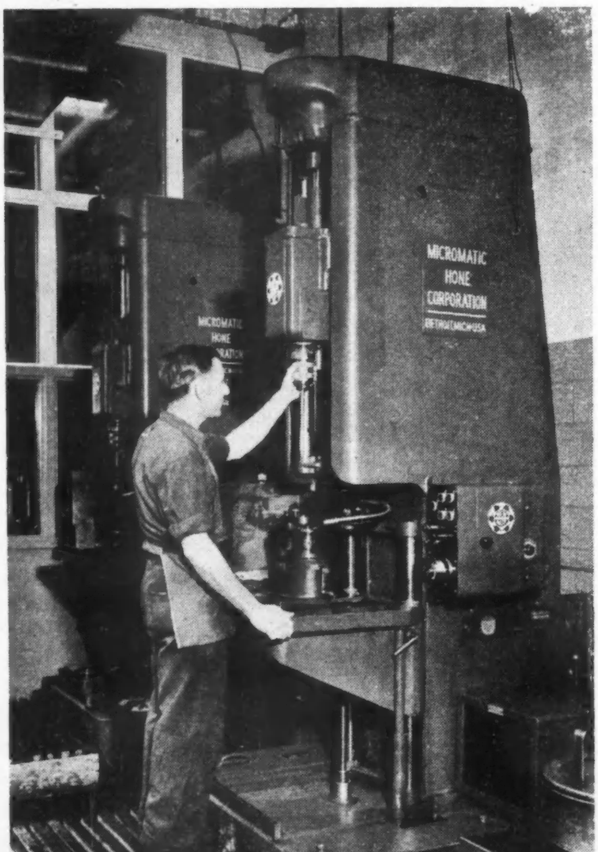






(Above) As an example of precision operations in the fuel injector department, here is the grinding of an injection nozzle valve on a fine bench machine, fitted with a tool-maker's microscope for magnifying the work.

(Below) Last word in precision honing equipment is this battery of two vertical Micromatic Microhoners, fitted with Micromatic hones. Plunger bores in gasoline injector pump housings are honed on these machines.



American Bosch

This is the 102nd in the series of monthly production features

IN ITS role as a major producer of fuel injection equipment and electrical accessories for Diesel and gasoline engines, the American Bosch Corp., Springfield, Mass., has made an outstanding contribution to the wartime program of the Army and Navy on land, in the skies, and on the seas. Some impression of the phenomenal growth of productivity achieved in recent years may be gained from the fact that although the peak volume of sales in 1938 was only $3,500,000, it catapulted to a high of some $65,000,000 in 1944.

Principal products of American Bosch—in war as well as in peace—include: Diesel fuel injection systems and accessories, aircraft magnetos, special tank engine magnetos, industrial engine magnetos, starting vibrators, heavy duty generators, voltage regulators, high tension coils and condensers, and electric windshield wipers. Commercial and industrial engine magnetos are built in six different sizes and in types for one to twelve cylinder engines.

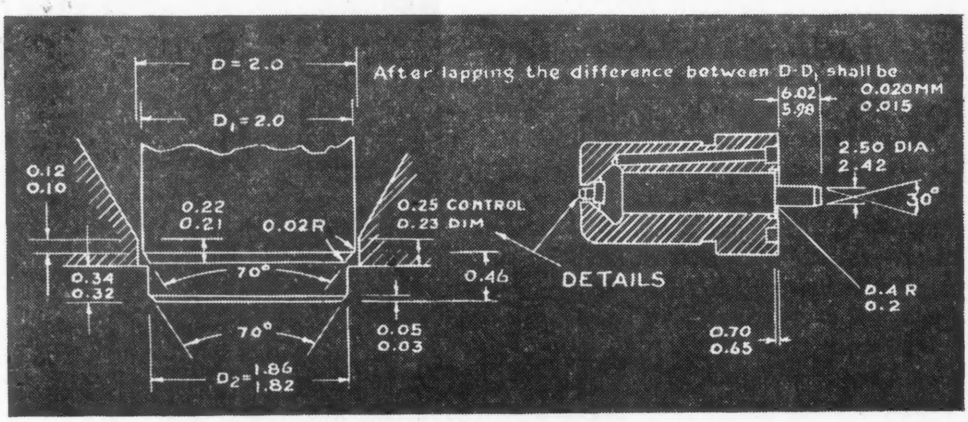
The most recent addition to the line is gasoline injection equipment. Although currently restricted and earmarked for military purposes exclusively, this new equipment will be available for postwar application on industrial and commercial gasoline engines. The availability of a practical system of solid injection for heavy duty gasoline engines offers an intriguing prospect for engine designers and engine users and marks this as an outstanding postwar development.

The manufacture of this varied line of products to meet numerous engineering requirements and designs of types and sizes poses a severe task for production management. A further complication is that relatively few parts or assemblies are ordered in large enough quantity to warrant the use of specialized single-purpose equipment. This is true despite the enormous output of all types and sizes of parts, in the aggregate. As an illustration consider the Diesel fuel injection activity. In the pumps, American Bosch has a group of single cylinder units in seven sizes, ranging from a tiny two-pound unit 5⅛ in. high to one which weighs 185 pounds and is 19 in. high. The line of injection pumps having built-in camshafts is manufactured in

By Joseph Geschelin

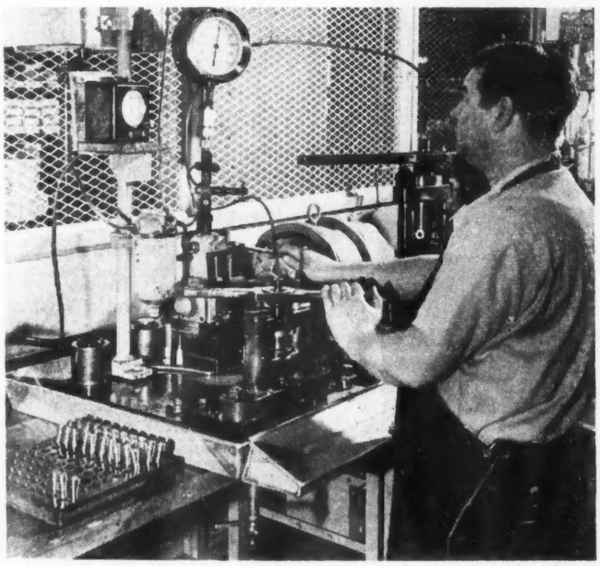
Products Made in

Self-Contained Departments



Details of the nozzle assembly

(Below) One of the fussy testing operations in the Diesel fuel injector department is the leakage test for plunger and barrel assemblies for the fuel pump. This test is proof of the running clearance of 0.000039 in. between the bore and plunger.



(Below) Among the most modern items of production equipment are two Cincinnati Duplex vertical Hydro-Broach machines. Splines in the drive coupling for aviation magnetos are produced on this unit.

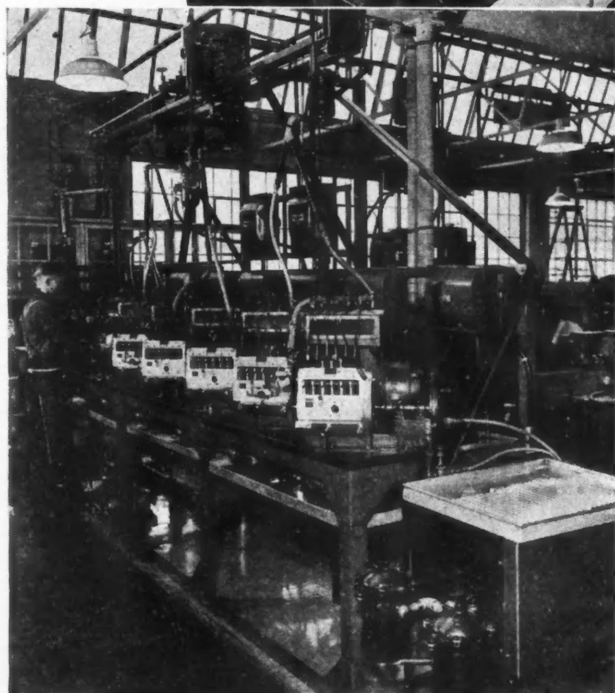
types ranging from one-cylinder to eight-cylinders and in three different size groups. The number of main functional units of the pump is greatly increased by the variations required as to the size of plunger, angle and direction of plunger helix, base or flange mounting for right or left hand drive and use of fuel supply pump and governor.

In addition, there is a companion line of precision-made nozzles, holders, fuel supply pumps, final stage filters, governors, lubricators and timing devices. In all, more than 800 nozzle variations are required to meet engine specifications which dictate variances in size, type and spray characteristics. *(Next page, please)*

Nozzle holders are produced in three general types, and in sizes and lengths for all applications. Fuel injection pump governors are made in four general styles with variations which are determined by engine applications. This is also true of timing devices and fuel supply pumps which are produced in three main types with variations to meet diversified engineering requirements.

Doubtless an industry-wide engine standardization program, if that had been feasible, would have gone a long way toward a reduction in the number of distinct styles and sizes of fuel injection equipment and accessories. Such standardization, however, would have had an adverse effect upon engine building programs and would have hampered the accelerated Diesel engine building program of the Army and Navy.

(Above) Typical of self-contained and specialized assembly departments is this one showing facilities for Diesel fuel pump assembly.



(Center) Prior to final calibration, ABC Diesel fuel injection pumps are run-in on the test stands shown here.

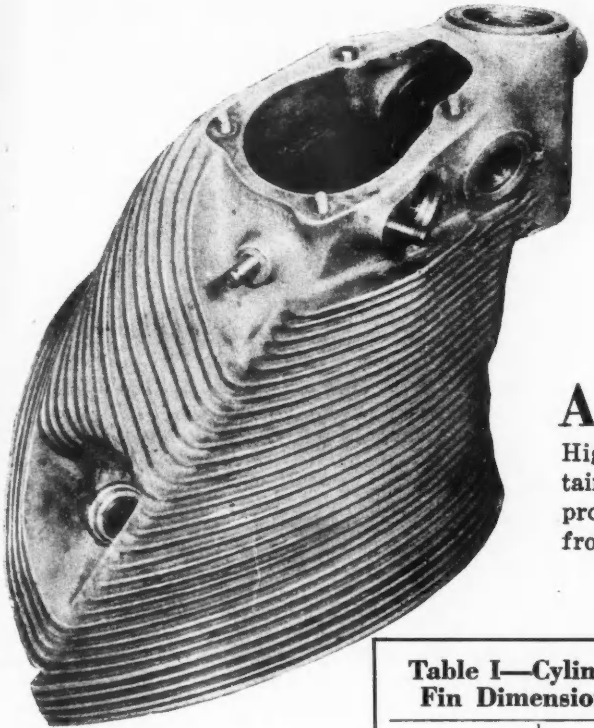
(Below) Skilled operators handle the drilling of spray holes in the Diesel fuel injection nozzles. Holes as minute as 0.004 in. are drilled on bench drills such as this one, the operator using an eyepiece or a microscope to magnify the tiny drill.

It was, therefore, up to the American Bosch to carry the brunt of the problem of variability, leaving the engine builders free to specify anything that would best suit their specific requirements. The net effect of all this has been to create a sort of glorified precision job-shop manufacturing operation in many respects. Despite that, the program has been accomplished with excellent economy by a skillful management of plant layout and facilities.

The manufacturing facilities of this plant are purposely laid out so that work operations radiate from what might be called a central hub. Here the work flows from general machine shop operations to the precision machine operations and thence to final hand lapping operations.

Each of the basic products mentioned earlier is fabricated, assembled, tested and re-tested in its own self-contained department. Thus, there are separate assembly departments for fuel injection pumps, for aircraft magnetos, for industrial magnetos, for windshield wipers and other products. Each of these, in turn, has its own self-contained facilities for the machining, grinding or lapping of special parts and components. For example, the industrial magneto department contains a line for machining the variety of hous-

(*Turn to page* 80, *please*)



Light Alloy Cylinder Heads

from German Aircraft Engines

A REPORT prepared by Dr. C. Wilson, director of the Metallography Department of the Research Laboratories at the High Duty Alloys Co., London, presents metallurgical data obtained by investigation of the composition, construction and properties of three types of light alloy cylinder heads recovered from German aircraft engines. The following summary of the report and the accompanying photographs are given here by the courtesy of the British Ministry of Aircraft Production.

The cylinder heads examined were removed from Bramo-Fafnir 323 and BMW 132 engines in Dornier 17s, and a BMW 801 in a Dornier 217. With the rocker box and the inlet and exhaust connections integral, all three cylinder heads were castings. The head of the BMW 153 was considerably damaged, but the other two were in good condition.

In all cases the main parting line of the molding boxes had run transversely across the closely pitched fins and the rocker box. The manifold and rocker box studs were screwed into the castings, but the valve seats and valve guide bushings had apparently been shrunk into position. In general, the appearance of the castings was good, with no obvious evidence of (*Turn to page* 54)

Table I—Cylinder Head Fin Dimensions (In.)

Engine	BMW 801	Bramo-Fafnir 323
Fin spacing at tip....	0.12	0.20
Fin thickness root...	0.10	0.10
Fin thickness tip....	0.08	0.08
Fin depth (max.)....	1.40	1.38

Above:
Fig. 1. Half cylinder head, BMW 801 engine, showing rocker box

Right:
Fig. 2. Half cylinder head, BMW 801 engine, showing manifold connection

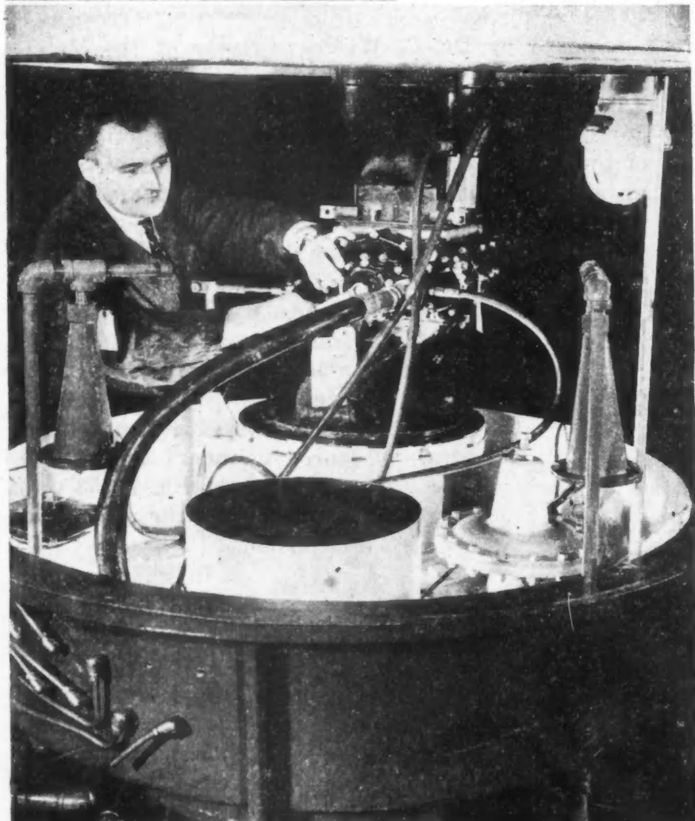
Below:
Fig. 3. Macrostructure in section of BMW 132 cylinder head

Table II—Composition of Cylinder Heads in Percentages

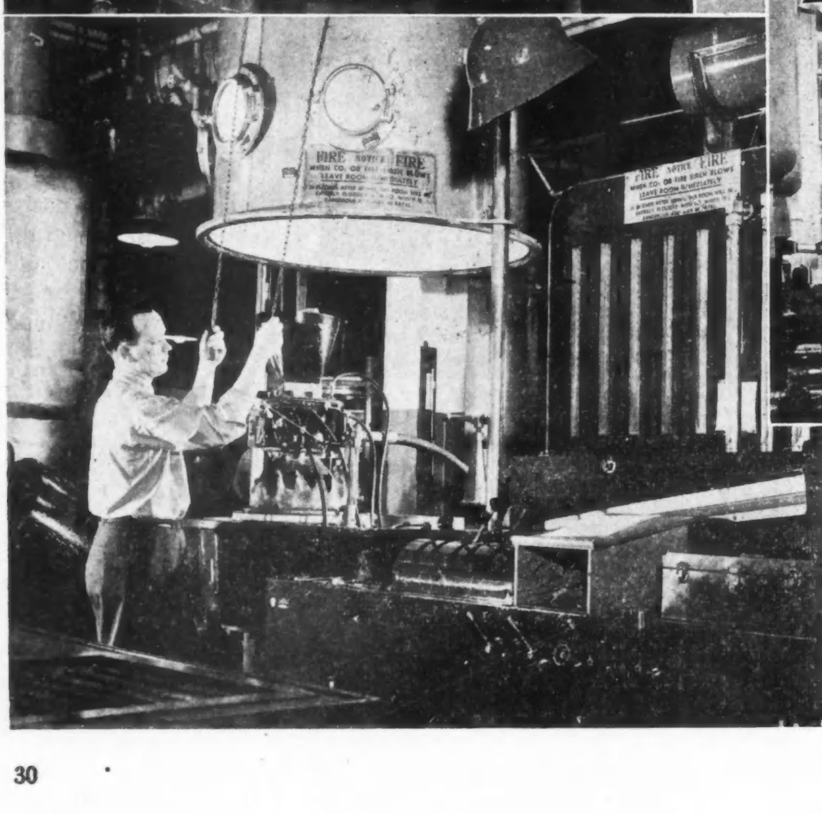
Engine Type	Cu	Ni	Mg	Fe	Si	Ti	Mn	Al
BMW 132........	10.10	....	0.27	0.96	0.14	0.04	0.02	Rem.
BMW 801........	....	....	4.88	0.37	1.27	0.11	0.15	Rem.
Bramo-Fafnir 323.	4.12	2.03	1.19	0.24	0.27	0.12	0.02	Rem.

Carburetor Test Chambers

at Plant of the Holley Carburetor Co.



(Upper left) Closeup of the test chamber interior. The two flanged nozzles are connected to the high pressure carbon dioxide, fire extinguishing system. The heat actuator is under the plate beneath nozzle at left.



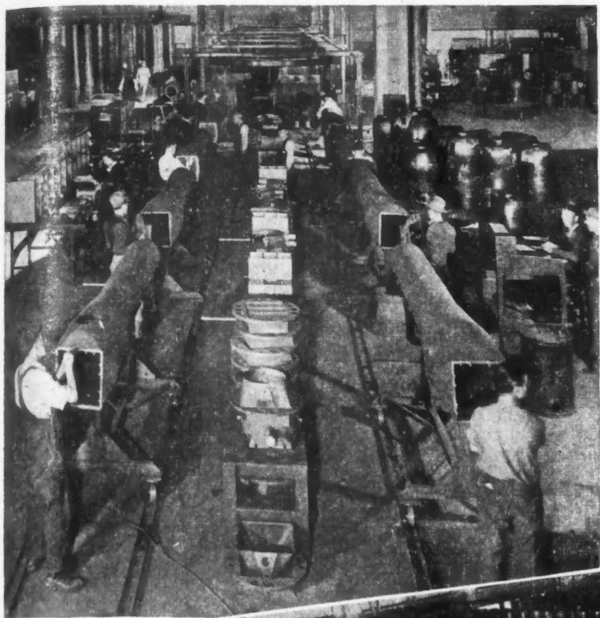
(Lower left) Test chamber (hood raised showing carburetor in place for testing under simulated flying conditions with hood lowered. The air intake projects at left of picture and the gasoline tank is in the upper right corner.

(Lower right) The entire test room at the Holley Carburetor Co. is protected by a carbon dioxide fire extinguishing system with 29 discharge nozzles located along the walls as shown in this photo.

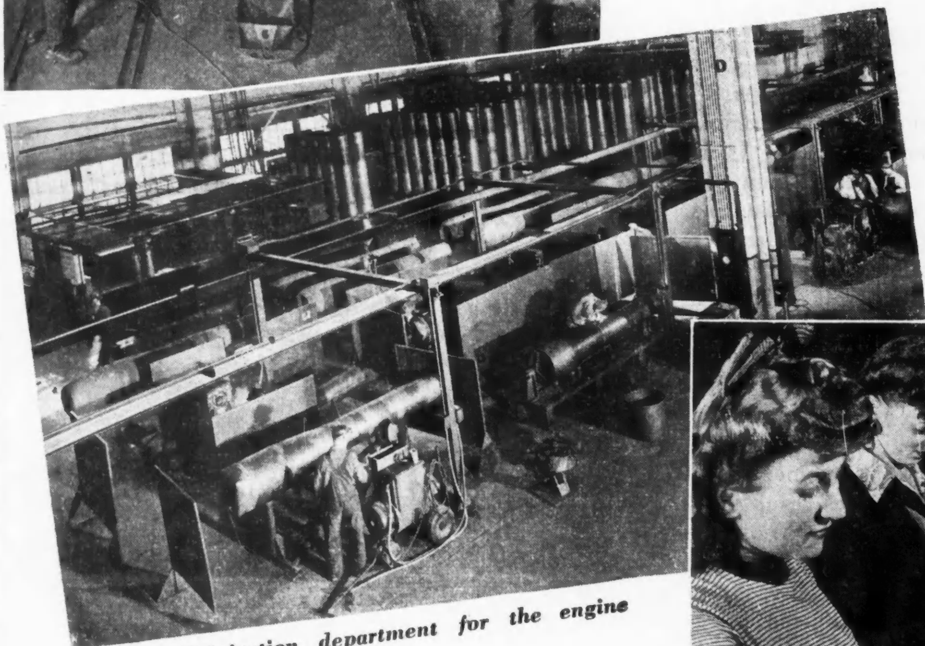
Jet Propulsion

Engines on the

Ford Assembly Line

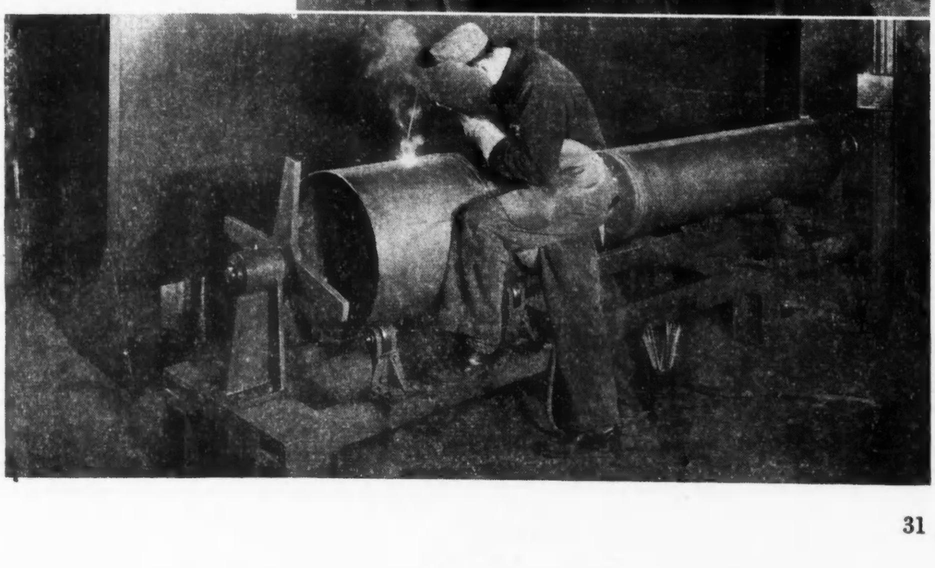


(Top) Jet propulsion engines being assembled at the Ford plant for American-type robot bombs. The workmen in the foreground are installing venturis, grills and nose cowlings on the partly completed engines.



(Above) Fabrication department for the engine castings.

(Right) Fuel metering devices are made at the Ford plant and then shipped with the engines to the manufacturers of the robot-bomb plane for installation in the fuselage.



(Right) Closeup of a workman welding the engine casing, which consists of the combustion chamber and a discharge pipe. The German version of this engine develops 575 thrust hp at 360 mph, equivalent to about 725 bhp in a piston engine with propeller.

Problems of Aircraft Engine Altitude

HIGH altitude has an adverse effect on all of the auxiliary functions of a combustion engine, because these functions depend in one way or another on either atmospheric density or atmospheric pressure, both of which vary with altitude. For instance, the ordinary carburetor delivers a mixture which becomes progressively richer with increase in altitude, and this condition must be corrected by the provision of altitude-compensating means. Ignition, likewise, is affected, because the rare atmosphere of the higher regions has a lower dielectric strength than the normal atmosphere, which favors flash-over and corona.

Lubrication is affected because the oil pumps depend chiefly on atmospheric pressure for "induction," that is, for filling the pump chambers with oil. If the pressure drops below a certain value, cavitation sets in, and the delivery per revolution is reduced. Besides, the pumps of aircraft lubricating systems under altitude conditions do not handle oil alone, but a mixture of oil with air and gas, and the rate of oil delivery is thus reduced. Air is introduced into the system by the scavenging pump. To make sure that the system will operate on the dry-sump principle under all conditions, the scavenging pump must be given a larger displacement than the pressure pump. As a result, the scavenging-pump inlet cannot be kept submerged in oil, and air is drawn in with the oil. Gases result from vaporization of the more volatile elements of the lubricant, under conditions of low pressure and high temperature, such volatile elements being present in considerable quantity especially if oil dilution is resorted to for cold-weather starting.

The problem of insufficient oil delivery at high altitudes due to aeration or foaming has confronted aircraft-engine and lubrication engineers for a number of years. It became acute during the early part of the current war, when combat flying called for higher ceilings. Considerable research work bearing on the problems involved has been carried out, and a symposium on results obtained to date was conducted some time ago at The Pennsylvania State College. It included a paper on the S-S System of Aircraft Lubrication by Prof. P. H. Schweitzer of The Pennsylvania State College and L. P. Sharples of the Sharples Corp., a paper on Aircraft Powerplant Lubrication Design and Operating Problems by W. L. Weeks of the Wright Aeronautical Corp., a report on Shunt-Type Lubrication System Airplane Installation Tests by E. A. Metz of Allison Division, General Motors Corp.,

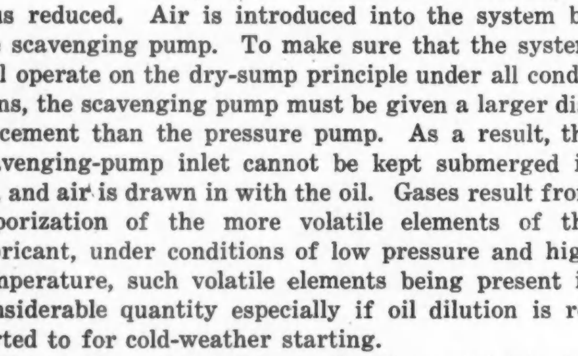


Fig. 1—Diagram of a conventional aircraft-engine lubricating system.

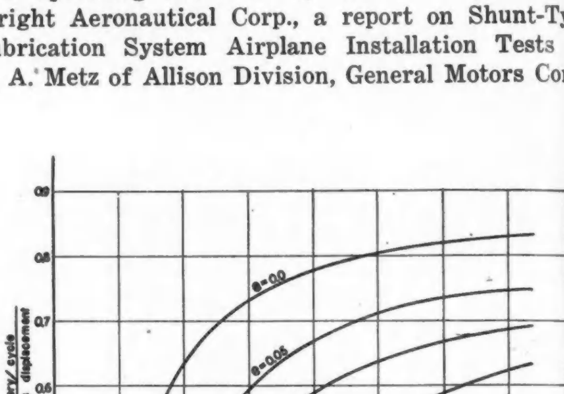


Fig. 2—Calculated oil delivery of a typical gear pump with 16 per cent clearance volume, for various degrees of aeration.

and a paper on A New Design Low-Suction-Loss, Rotary Pump by R. J. S. Pigott, chief engineer of Gulf Research and Development Co. The shunt-type lubrication dealt with by Mr. Metz is the S-S system described in the paper by Schweitzer and Sharples. This article is based on these papers.

Wright Aeronautical Studies

Mr. Weeks mentioned that the altitude limitations of engine lubrication systems were brought into bold relief when the Wright Aeronautical Corporation had its first case of severe air entrainment. It was on a plane in which the ratio of scavenging-pump capacity to engine oil flow was quite high, and which had a hopper-type oil tank of unusual (and from this particular point of view, unfavorable) design. The firm already had carried out some tests which had made it evident that the pressure pump operates to best advantage when the entrained air is at a minimum, but at that time no instrument was available with which the amount of entrained air could be measured. En-

Lubrication and Their Solution

gine builders were first to realize the importance of the separator function of the oil tank. A study of hopper inlet fittings showed that most of them were of poor design from the separating point of view, the jet in most cases carrying the oil and the entrained air in a straight path to the tank outlet, instead of spreading the oil over the tank walls and giving the air a chance to escape. Efforts were made to get improved hopper designs, but the conclusion was finally reached that even if the oil were spread over the entire interior surface, the short time available would not permit any great part of the finely-divided gas to escape.

By P. M. Heldt

A study of oil systems external to the engine revealed that not enough importance is attached by designers to low flow resistance in oil-pump suction lines, which were found to comprise such features as 90-deg. drilled fittings and quick disconnects with a flow resistance as high as a couple of inches of mercury. While it was recognized that air entrainment originates in the engine, there was no obvious method of eliminating the trouble at the source that could be put into effect quickly. Air separation therefore was discussed with plane manufacturers, with the idea that they should consider it when next designing new oil tanks and oil systems for use with current engines.

At present the factors responsible for the trouble are fairly well understood, and methods of eliminating them are known, but, unfortunately, no remedial measures that call for changes in standard engine components can be considered, owing to the "frozen design" situation.

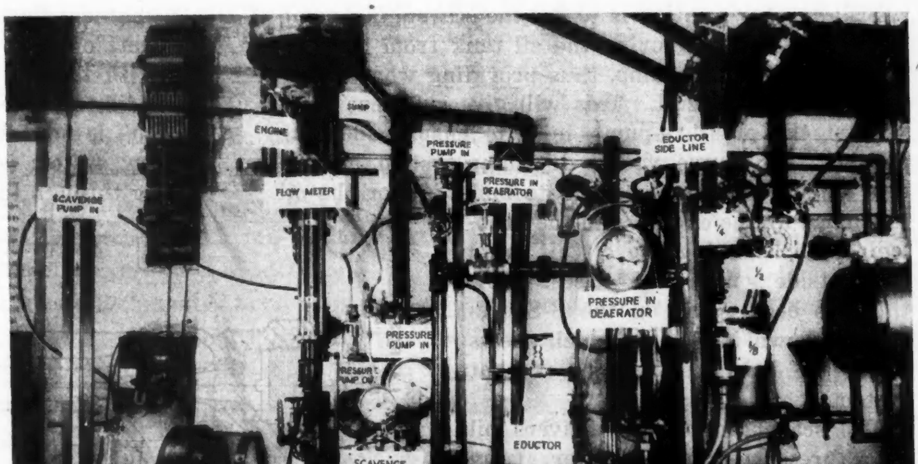
Pressure pumps preferably should be designed so that their pump chambers will fill fairly up to 40,000 to 50,000 ft. As regards scavenging pumps, every cubic inch of displacement in excess of actual requirements handicaps the oil tank in altitude operation, because it must separate that much more air. That, of course, could be corrected, but not "over-night," and even if the scavenging pump were so designed that its capacity just sufficed to remove the oil collecting at the bottom of the sump, separator action would still be called for, because of the considerable amount of gas delivered with the oil.

Wright Aeronautical Corp. has become interested in the Focke-Wulf "hot-tank" system as a remedy for extreme cases of air entrainment, even though an auxiliary pump must be supplied with it. The corporation, in its efforts to solve the problem, has concentrated on those factors which are susceptible to easy change, provided the change will not affect the engine structure in such a way as to delay production. The problem has been further complicated by the comparatively recent practice of oil dilution for cold-starting.

Mr. Weeks summed up the current situation with respect to operating conditions of lubricating systems under high-altitude conditions in the following two paragraphs:

"Present powerplant lubrication systems are not capable of extreme altitude operation, because they will not handle as compressible a medium as they manufacture and too rapidly circulate. We do not now have time to replace oil pumps and oil tanks. We must temporarily add some complication, to permit the present ones to do the job. Where scavenging is critical because the pumps were designed to match the too-low ceiling of the pressure pump, we must augment scavenge by auxiliary means, since we cannot pressurize engine oil sumps at present.

"With reference to cold-starting requirements, present engines were not designed to act as flash boilers of gasoline in their crankcase. If they must be run as such for short periods, we must expect to provide auxiliary means which will permit them to do it."



Set-up for switch-over tests in the Diesel Laboratory of The Pennsylvania State College.

The S-S System

Messrs. Schweitzer and Sharples in their paper pointed out that the immediate cause of failure of lubricating systems in altitude operation is insufficient pressure-pump inlet pressure. Fig. 1 shows a conventional aircraft-engine lubrication system, with gravity feed from the oil tank to the pressure pump. In Fig. 2 calculated deliveries of a typical gear pump with various degrees of oil aeration are plotted against the absolute pressure in the oil tank. If it is assumed that the minimum delivery at which the engine can operate is 50 per cent of normal, the minimum permissible barometric pressure for any degree of aeration can be found from the chart, and the barometric pressure can be easily converted into altitude. It is thus found that with an aeration of 10 per cent, for instance, lubrication would break down at 32,000 ft.

The difficulty could be overcome by the installation of a booster pump, either in or near the oil tank, but the need for an extra drive for this pump is a disadvantage. Another solution would be to "pressurize" the tank by throttling its vent. It is understood, however, that the Army is opposed to this method.

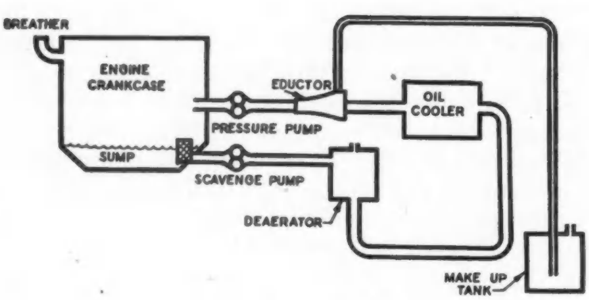
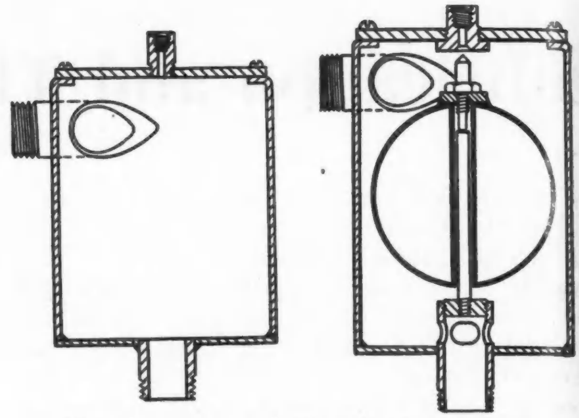


Fig. 3—Diagram of the S-S system.

Still another solution is to use the scavenging pump as a booster, by removing the oil tank from between it and the pressure pump, thus providing what is virtually a closed circuit. This will give sufficient pressure at the pressure-pump inlet to ensure adequate delivery. Of course, with a dry-sump system, an outside supply of oil is required, to make up for the oil consumed by the engine, and the problem of replenishing the circuit from this outside source then arises. How this has been solved in the S-S system is shown in Fig. 3, which shows all of the basic components of that system.

The scavenging pump delivers oil to a pressure-type deaerator, from which it flows to the cooler, and from there through an "eductor" to the pressure pump, which delivers it to the engine. From the eductor there is a connection to the make-up tank.

The system, of course, is not absolutely closed, because the deaerator is vented to the atmosphere, and the make-up tank, which opens into the circuit at the eductor, also is vented. Both vents, however, are relatively small, and permit of the existence of super-atmospheric pressures in the circuit. With a conventional lubrication system at sea level, the pressure at the pressure-pump inlet is approximately atmospheric, while with the S-S system it is about 6 psi gage. At 40,000 ft, the inlet pressure with the conventional system is about 5 in. of mercury; with the S-S system, 15 in. With the latter inlet pressure the supply of lubricant to the engine is ample.



Figs. 4 and 5—Valveless (left) and float-valve (right) types of deaerator.

The chief advantage claimed for the system is that it raises the "lubricating ceiling"; that is, the altitude at which lubrication ceases to be satisfactory. Besides, it is lighter, and also somewhat simpler than the conventional system, because a plain oil tank replaces the hopper type, and the tubing between the tank and the pressure pump is smaller in diameter. The tank, moreover, can be installed in any convenient spot on the plane.

The system also offers advantages in connection with the use of oil diluent as a means to facilitate cold-weather starting, and this was emphasized by Mr. Metz of Allison, who conducted flight tests with it. With the conventional system all of the oil has to be diluted, while with the S-S system the oil in the tank is not affected. An incidental advantage of the new system is that the air entrained by the oil passing through the scavenging pump is separated out

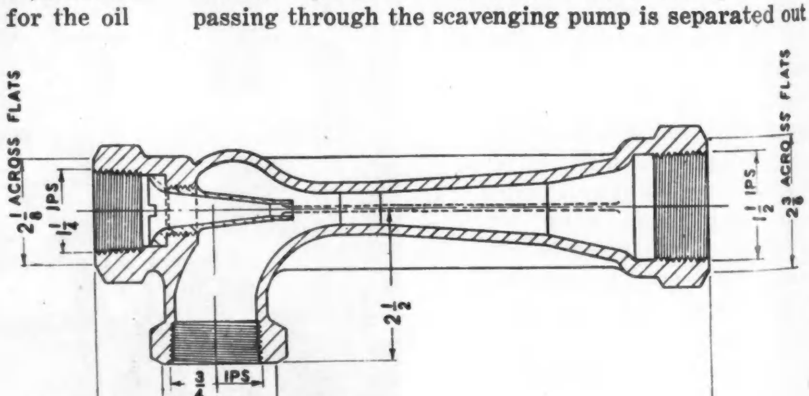


Fig. 6 — Sectional view of the eductor supplied by Schutte & Koerting Co.

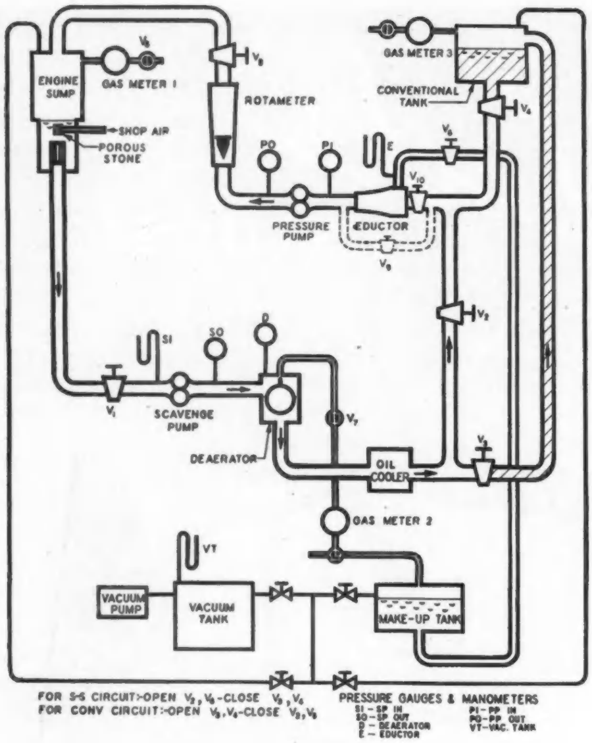


Fig. 7—Bench set-up for switch-over tests.

ahead of the cooler, hence the pressure drop through the cooler is lower. There is a general lowering of pressures in the system ahead of the pressure pump, which increases the efficiency of the scavenging pump and reduces the likelihood of leakage. Location of the deaerator ahead of the cooler makes for more effective air separation, because the hotter (and less viscous) oil gives up the air bubbles more readily.

In connection with aircraft-engine auxiliaries containing liquids, the question of their behavior in inverted flight always arises. Mr. Metz pointed out that with the shunt system as now arranged, in inverted flight the engine will receive somewhat less oil than with the conventional system, but he expressed the opinion that this could be easily remedied.

Deaerator

The deaerator used with the S-S system is a development of the Sharples pressure-type cyclonic deaerator. It may be used in either the valveless or the float-valve form, the two types being illustrated in Figs. 4 and 5, respectively. Each consists of a small cylindrical chamber with a tangential oil inlet at the top and a central oil outlet in the bottom. There is a small air outlet in the top. In the valveless type this air outlet is so restricted that enough pressure builds up in the deaerator to force the oil through the cooler and eductor nozzle. At the same time there is a constant flow of separated air and oil foam through the air outlet. In test equipment described further along in this article, the outlet orifice has a diameter of 1/16 in. From the air outlet a tube leads to the make-up tank, where the entrained oil has a chance to separate out, and the air can escape to the atmosphere through the vent.

In the float-valve type of deaerator, the valve opens and closes alternately. When it is closed, air accumulates in the deaerator, pressure builds up therein, and the oil level is depressed. The float then sinks and the valve opens, allowing the air to escape. This in turn results in a drop in pressure in the deaerator, a rise in the oil level, and closing of the valve. The size of the air-outlet orifice is not critical, pressure conditions in the system being controlled by the float. At sea level the float valve opens and closes about 40 times per minute, and the pressure in the deaerator ranges between plus and minus 1.5 psi. When the amount of air separated is small, the valve remains open for a relatively short time, and *vice versa*.

Both types of deaerator have substantially the same separating efficiency. Tests have shown that with between 15 and 50 per cent air in the mixture entering the deaerator, all except about 3.5 per cent is separated out, except when the air is very finely dispersed in the oil by a high-speed scavenging pump, or the oil is wet, in which case the percentage of air remaining in the oil may be slightly higher. Air separation in the deaerator is facilitated by the tangential entry which spreads the oil over the cylindrical surface and causes little splash.

Self-Regulating Feature

From the deaerator the oil passes through the cooler to the eductor. This device (Fig. 6) operates on a principle similar to that of a steam ejector. The oil delivered by the scavenging pump passes through a nozzle in which its static pressure is largely converted to dynamic pressure. This results in a low pressure in the space surrounding the nozzle. From this space a tube connects to the make-up tank. When the circuit contains the normal amount of oil, the pressure at the throat is approximately atmospheric, and there is then no flow through the make-up line. As oil is consumed by the engine, the throat pressure drops, and the atmospheric pressure in the make-up tank then forces oil through the make-up tube into the circuit. The make-up tube is filled with oil at all times, but under normal conditions there is very little flow through it.

The explanation of this self-regulating phenomenon is that the pressure produced in the circuit by the scavenging pump rises and falls with the amount of oil in the circuit. If the general pressure level in the circuit drops, eductor-throat pressure drops, and oil is then sucked into the circuit through the make-up tube, while in the contrary case it is forced out of the circuit into the make-up tank.

This characteristic of the system can be nicely demonstrated on the experimental set-up. If a pint of oil is removed from the system, or the oil level in the sump is allowed to drop 0.05 in.

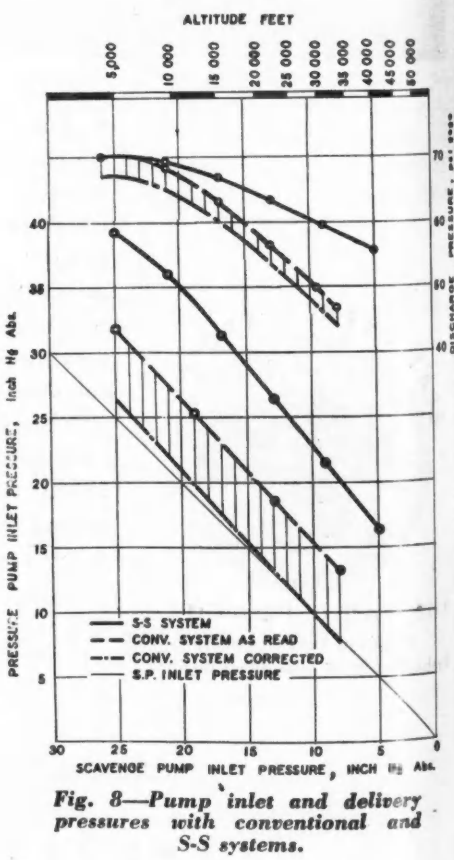


Fig. 8—Pump inlet and delivery pressures with conventional and S-S systems.

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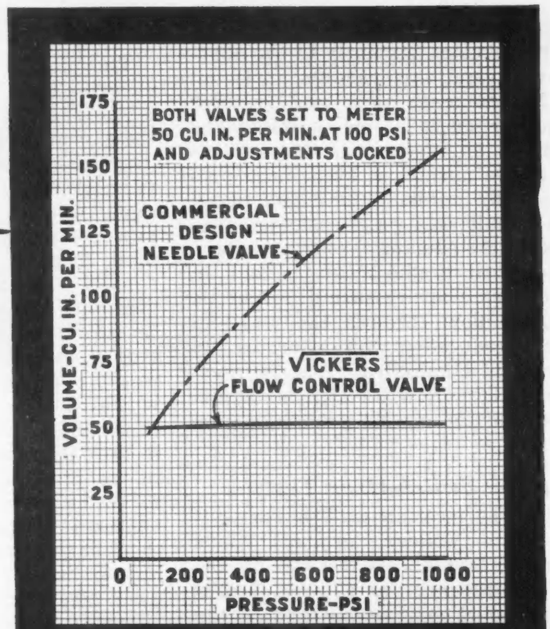

All readings taken at constant temperature of 120° F. with oil having viscosity of 200 S.S.U. at 100° F.

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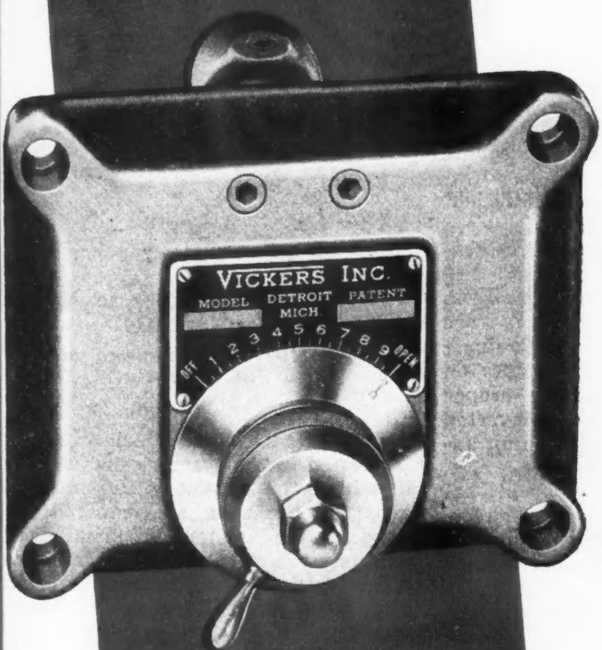

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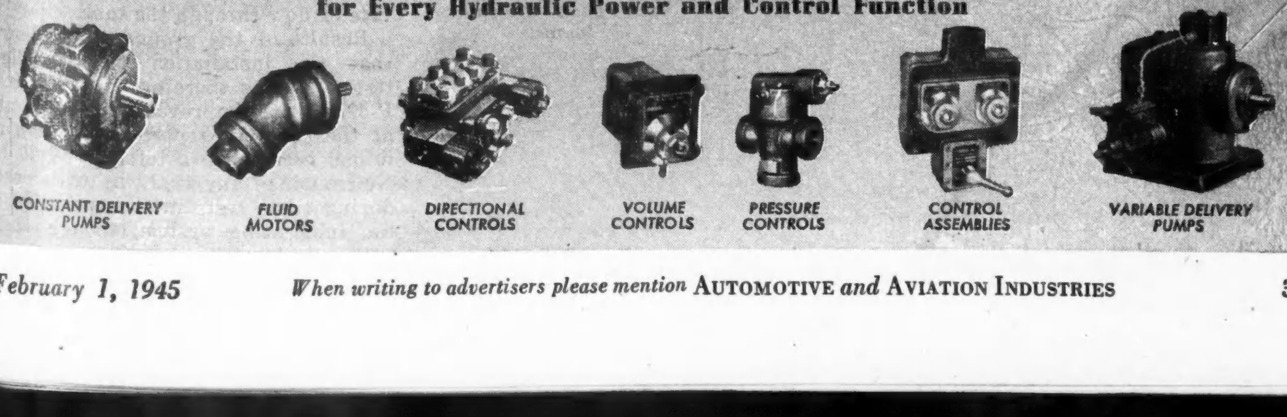

below normal, a vacuum of 8 in. of mercury develops instantly in the eductor throat, and this vacuum sucks oil from the make-up tank and restores the equilibrium in a few seconds. The reaction to an increase in the amount of oil above normal is even more pronounced. An excess of one pint of oil in the circuit will produce a pressure of 8 psi in the eductor throat, and force the excess oil to the make-up tank in quick order. The pressure differentials that cause flow through the make-up line are produced in the deaerator. If that unit is eliminated from the system, there is no flow through the make-up line, and the circuit gradually goes dry.

Set-Up for Switch-Over Tests

During the meeting at The Pennsylvania State College, demonstrations were made on a test set-up in the Diesel laboratory, the set-up permitting of a direct comparison between the conventional aircraft-engine lubricating system and the S-S system. A photograph of the set-up is shown on page 36 and a diagram in Fig. 7. Referring to the diagram, by opening valves V_2 and V_6, and closing valves V_3 and V_4, the set-up is made to work as an S-S system, while by closing valves V_2 and V_6 and opening valves V_3 and V_4, it is made to work as a conventional system. The change-over from one system to the other can be made quite rapidly. Pressure gages and manometers are installed at all points for which it is desirable to know the pressure conditions. The pressure pump forces the oil through a Rotameter-type flowmeter, and then through the adjustable $valve_5$, which represents the restriction due to the engine bearings in the regular installation. After passing through this valve, the oil collects in the sump. The amount of air taken in from the atmosphere by the sump is indicated by a gas meter. Extra air may be introduced under pressure through a porous stone. In altitude tests, both the sump and the make-up tank can be put under vacuum by means of a vacuum pump and tank.

Laboratory Test Results

The most important results of comparative tests with the set-up are plotted in Fig. 8. The lower set of curves show that the S-S system boosts the pressure-pump inlet pressure 8 in. of mercury under all conditions, while the upper set of curves shows that the pressure-pump delivery pressure drops with increase in altitude much less rapidly with the S-S than with the conventional system. In the experimental set-up the tank of the conventional system (marked "Conventional Tank") was 7.5 ft above the pressure pump, which gave a pressure head of 5.5 in. of mercury. This is taken account of in the "Corrected Curves" in Fig. 8, 5.5 in. of mercury column below the observation curves. In the tests the conventional system was favored also by the fact that instead of the conventional hopper tank, a larger plain tank was used, which acts as an efficient air separator. It is claimed that in its present form, the S-S system gives a lubricating ceiling 20,000 ft higher than that of the conventional system with a "perfect" tank.

With the S-S system the lubrication ceiling is determined by the scavenging pump, rather than by the pressure pump, and the scavenging pump (or pumps) therefore should be of adequate capacity and have an unobstructed inlet. The deaerator must be of sufficient size to take care of the air delivered by the scavenging pump, but no definite rule regarding the optimum size of deaerator has yet been formulated. Where several scavenging pumps are used, they may deliver into a single deaerator at equally spaced points on the circumference. To ensure proper operation of the deaerator in inverted flying, it must be provided with an additional vent in the bottom.

A pressure pump of conventional type may be used, but it will be necessary to make a slight change in the by-pass line, which ordinarily leads from the discharge side directly to the suction side. This arrangement works well when the pressure on the suction side is always below atmospheric, but may give trouble when it is above atmospheric, as it is in the S-S system at ground level. This can readily be provided for, however.

While the oil tank may be located in any convenient position on the plane, provisions must be made to prevent congealing of the oil in extremely low temperatures. It is recommended that some hot oil be bled into the tank from the deaerator.

Flight Tests by Allison

The report by Mr. Metz on installation tests with the system was of a preliminary nature, the tests not having been completed at the time it was

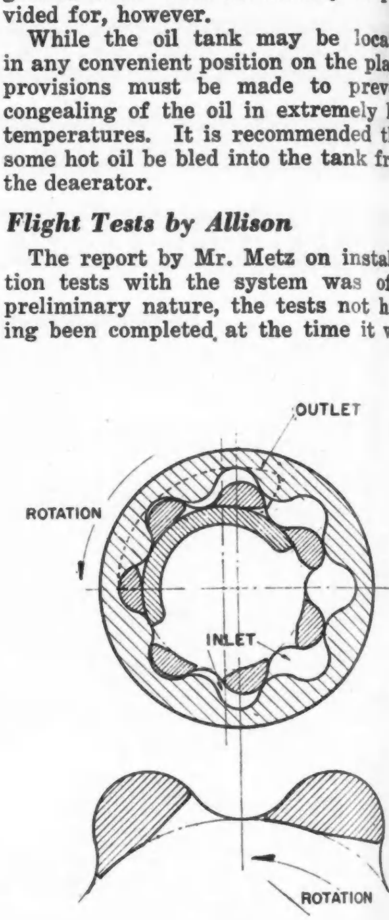

Fig. 10—Final shape of suction port.

written. It seems that Allison became interested in the system chiefly because it reduces the amount of circulating oil about 50 per cent, as compared with some current "winterized" installations, and only the circulating oil needs to be diluted to facilitate starting. A ground-test comparison between a conventional and the S-S installation showed that the latter reduced the scavenge-pump back pressure approximately 40 per cent, and multiplied the pressure-pump inlet pressure by from two to five. To judge by visual observations, air separation with the S-S system was as good as, or better than, with the conventional system. A moderate amount of oil foam passed continuously from the deaerator to the tank under all conditions. The particular installation and the time available for the tests did not permit determination of optimum line and orifice sizes, and of the rate of flow through the tank.

Results of the ground tests showed that the installation merited flight tests. It was therefore installed in a P-39N, with improved plumbing, and at the time the report was drawn up it had been flown a total of 26:20 hr. No trouble of any kind was experienced during these tests in the operation of the lubricating system, though there

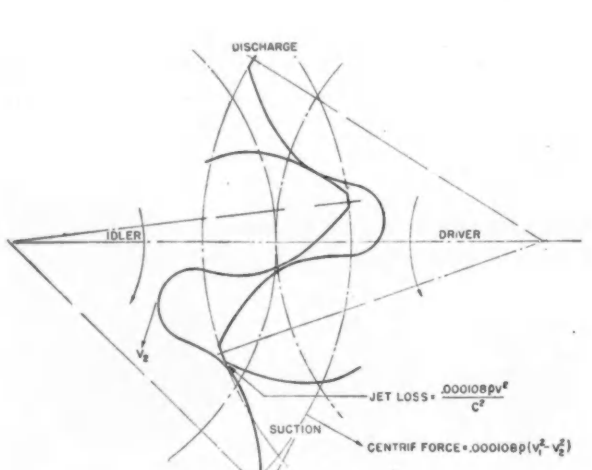

Fig. 9—Diagram of spur-gear tooth losses.

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A machine has been patented for making barrels out of cardboard for packing butter, flour, sugar, chemicals, fruits, or small parts. *Everett Industries, Akron.*

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Aviation and electrical engineers are collaborating on an electric drive for aircraft. This will, if practical, permit the location of engines in the fuselage and do away with nacelles in the wings. *Hughes Aircraft Co. and Westinghouse.*

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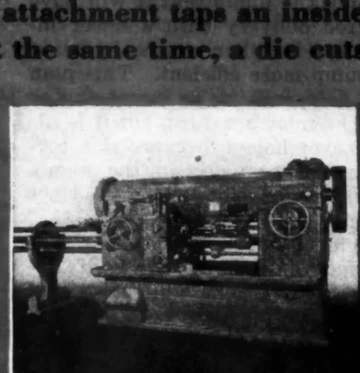

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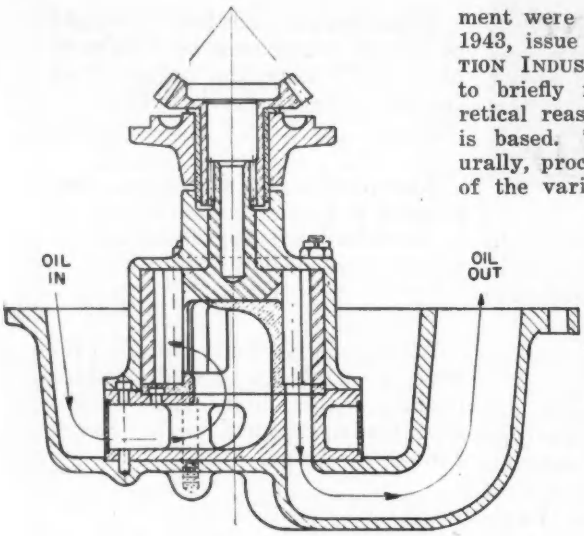

Fig. 11—Bottom-inlet type of aircraft-engine scavenging pump.

was considerable trouble with the instrumentation. It was concluded that additional test work was necessary to indicate specifically where improvements were needed, and the view was expressed that there was most room for improvement in the efficiency of the deaerator, to ensure improved operation of the system under both normal and acrobatic flight conditions.

Mr. Metz concluded his report with a summary of advantages and possible disadvantages of the shunt system, and these were referred to earlier in this article, in connection with the advantages claimed for the system by its sponsors.

Improvements in Oil Pumps

It was pointed out in the early part of this article that lubrication failure in aircraft engines at high altitudes is due to insufficient oil delivery by the pressure pump, which in turn is due to insufficient pressure at the pump inlet. It was also stated that the way to overcome the difficulty is to increase the pump inlet pressure. There is, of course, also another way in which the problem can be attacked, and that is, by so designing the pump that it will have the required delivery with a lower inlet pressure; in other words, by making the pump more efficient. This plan is hardly as promising as increasing or boosting the inlet pressure, but it is attractive, nevertheless, because if a corrective can be provided in the pump, engine design and installation need not be disturbed.

Development work along this line was carried through by the Gulf Research & Development Company, and was reported at the meeting by R. J. S. Pigott. The research project culminated in the design of an oil pump comprising an internal gear and a spur pinion meshing with it, with inlet ports between pinion teeth and an axial delivery port at one end of the housing. This pump and some of the experimental work which led to its development were dealt with in the Dec. 15, 1943, issue of AUTOMOTIVE AND AVIATION INDUSTRIES, and it remains only to briefly review some of the theoretical reasoning on which the design is based. The reasoning, quite naturally, proceeded from a consideration of the various pressure losses in the conventional gear pump. Two of these losses are grouped under the heading of "tooth losses" and are indicated in Fig. 9. The oil enters the pump chamber at the periphery, and immediately has a rotary motion imparted to it, so that it is subjected to centrifugal force. As it must flow inward to the bottom of the tooth space, it must overcome the centrifugal force, and this naturally occasions a pressure drop. Secondly, as the tooth of one gear enters the tooth space of the other, it forces the oil from this space. During part of the meshing period the oil has to pass through a rather narrow opening between the meshing teeth, and then forms a jet, and this gives rise to another pressure loss. In addition, there are losses due to skin friction in the inlet passage and suction chamber, and to changing from a relatively high oil velocity in the inlet tube to a materially lower velocity in the tooth spaces at the periphery of the gears, where the cross section is larger. There also may be some pick-up shock as the oil enters the tooth spaces, though it has not been possible to verify this experimentally.

In the Gulf pump the centrifugal loss is eliminated by causing the oil to enter through a central port, so that it flows radially outward in the pump chamber, and the shock loss is reduced by providing a tangential (instead of a radial) inlet port, so that there is no sudden change in the direction of flow of the oil upon entering the pump chamber. After these changes had been made, the bottoms of the pinion teeth still offered a considerable flat area to the port in the "cup," which caused interruptions in the flow. The ports were then milled so that practically a feather edge was presented to the pick-up, and there were no sharp corners to the incoming side. The ports then were shaped as shown in Fig. 10, and with this design the "breakdown pressure" was reduced to 3 in. of mercury, which is said to be good for 50,000 ft. altitude. With this model as a basis, both scavenging and pressure pumps were designed, and tested for delivery under varying inlet pressures. The design of an aircraft-engine scavenging pump with bottom inlet is shown in Fig. 11.

French Industrialists Must Share Control Of Plants with Workers' Representatives

By W. F. Bradley,
Automotive and Aviation Industries
European Correspondent

French automotive manufacturers, in common with all other industrialists employing more than 50 hands, will shortly have to admit workers to an important share in the control of their business. The Comités d'Entreprises decreed by the provisional government of France are theoretically consultative bodies elected by the workers in proportion to the number of hands employed.

The delegates, who are independent of the employers, will be elected, according to the decree, by the workmen, clerical staffs, engineers, heads of departments, foremen, etc. So far as social work in the factory is concerned, they will merely carry on the operations inaugurated by the Vichy government. The new Comités d'Entreprises have, however, been given much wider powers. They are allowed to interfere in the technical operations of the factory, the balance sheet must be submitted to the workers one month before it is presented to the shareholders, and they can discuss prices and contracts.

The workers' committees being consultative bodies, will merely submit their suggestions to the owners, but the latter are obliged to reply to these, giving their reasons for non-acceptance or only partial acceptance, and in case of disagreement the case will be taken before the Ministry of Industrial Production, which will set up machinery to deal with these matters.

It would appear that the Government is not yet completely decided as to the exact terms of the decree and detail changes may be made before it goes into effect and modifications, dictated by experience, may be made after it has been applied. Manufacturers, however, are not showing much enthusiasm for the new system. Even those who have no aversion to receiving suggestions from the workers regarding internal operations, point out that this effect will be nullified by the system of selection of the delegates. Voting takes place by unions, and the most powerful union is the C.G.T. (Confédération Générale du Travail) which has as its ultimate object workers' control of all industrial enterprises. The C.G.T. does not have an absolute majority, but it is more powerful than any other single union and in consequence will dominate the elections.

In practice, therefore, the members

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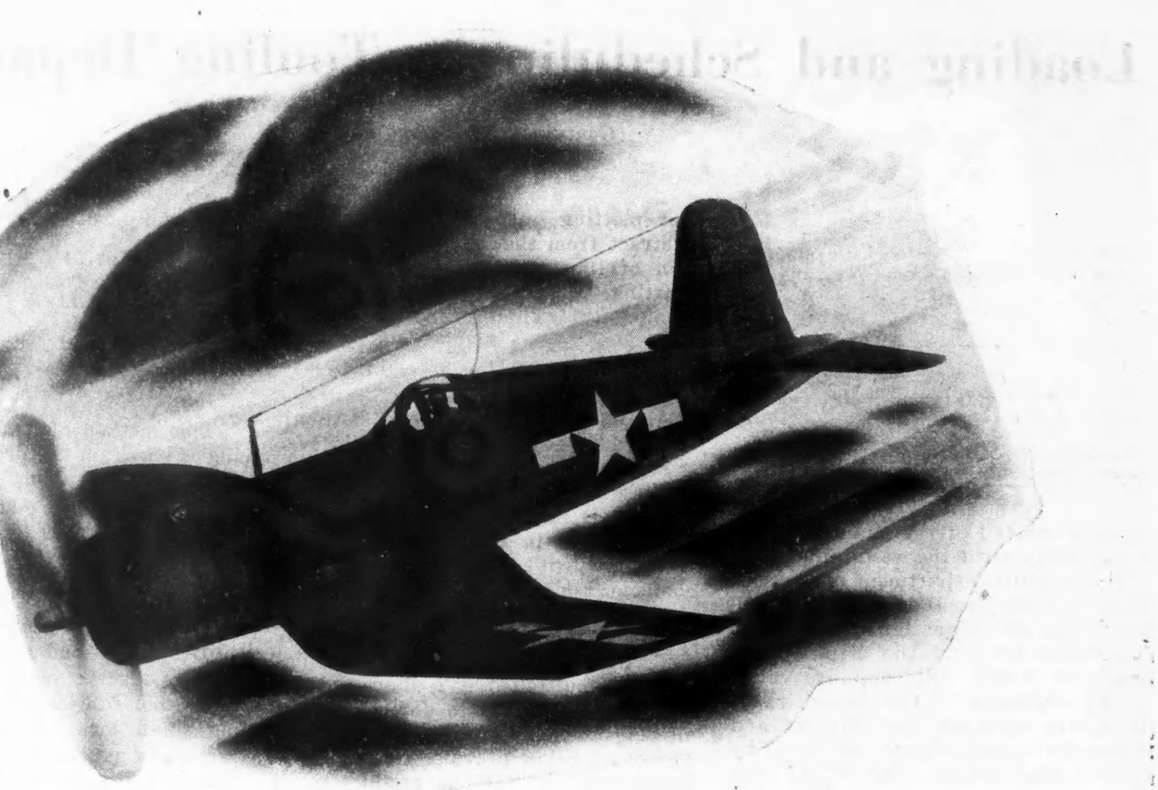
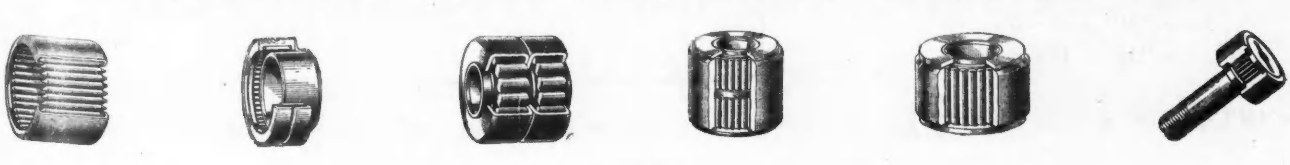
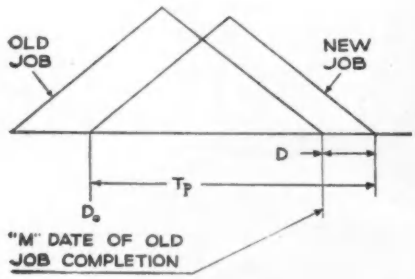




Loading and Scheduling a Tooling Department

(*Continued from page 24*)



capacity instead of the "hunting" that is necessary with the resultants.

The planning department of Consolidated Vultee's San Diego division is divided into groups assigned to definite geographic areas of the airplane (as indicated in Fig. 12), and are called "group segments." The capacities of the group segments are different and reflect the volume of work as issued by product engineering. The "*C*" of each group segment varies as the number of tool planners in the group segment, and the "*D*" between two jobs will vary as the "*C*" assigned to a particular airplane. The unit of capacity is one tool planner plus the fractional part of each other function necessary to complete the planning.

We have previously shown that the breakdown of each type of function is based on the tool planner's standard time of 1.0000 man-hours per dash number with a resultant time of 3.4844 man-hours per dash number for complete planning. For each tool planner, there are (150-43)/43 other personnel, or 2.49 (use 2.50) auxiliary personnel to plan a job complete; therefore, the unit of capacity "*C*" for tool and operation planning is 3.50 × 8 or 28 man-hours per day. Further:

$$D = \frac{M_p n}{C} = \frac{3.4844n}{28P} = 0.1245\,\frac{n}{P}$$

where "*P*" is the number of tool planners per group segment assigned to a model, if model loading is desired, or total tool planners per group segment, if jobs are scheduled without selection as they arrive in the general release group of the tooling department.

For convenience, the following equations are developed so that (given the completion date of the old job), the starting date D_o of a new job may be quickly determined (see Fig. 13):

$$D = 0.1245\,\frac{n}{P}$$

$$T_p = 0.582\sqrt{n}$$

$$D_O = \text{"}M\text{"} + D - T_p$$
$$= \text{"}M\text{"} - (T_p - D)$$

$$= \text{"}M\text{"} - \left(0.582\sqrt{n} - 0.1245\,\frac{n}{p}\right)$$

For plotting purposes, the amount to subtract from the "*M*" date of completion of the last job to determine the starting "*M*" date of a new job will be termed "D_t." Therefore:

$$D_s = 0.582\sqrt{n} - 0.1245\,\frac{n}{p}$$

All calculations presented here are based 80 per cent loading. However, it may be advisable to use more or less loading as occasion demands. To alter the loading so the chart for rapid calculation shown in Fig. 14 may be used, the equivalent dash numbers may be changed. For example, if it is desired to change from 80 per cent loading to 40 per cent loading, the value of "equivalent dash numbers—80 per cent loading" would be multiplied by 2, allowing twice as many man-hours to do the job and altering the elapsel times accordingly. The chart below provides the multiplying factors of "$^n80$" to produce n_x at required loading P_x:

P_x	n_x	P_x	n_x
105%	0.761	70%	1.142
100%	0.800	65%	1.230
95%	0.842	60%	1.333
90%	0.888	55%	1.452
85%	0.940	50%	1.600
80%	1.000	45%	1.778
75%	1.066	40%	2.000

This method of loading and scheduling is based on the probability that 250 or more "equivalent" dash numbers of work as issued by the tool and operation planning section will load all succeeding tooling department sections according to the distribution and man-hours of work. A small job of one to ten dash numbers may use only the facilities of one tool fabricating unit, yet it may reserve man-hours of time in other tool fabricating units. Succeeding small jobs ultimately build up a backlog of available man-hours not used in other departments, but as long as there is at least the minimum of 250

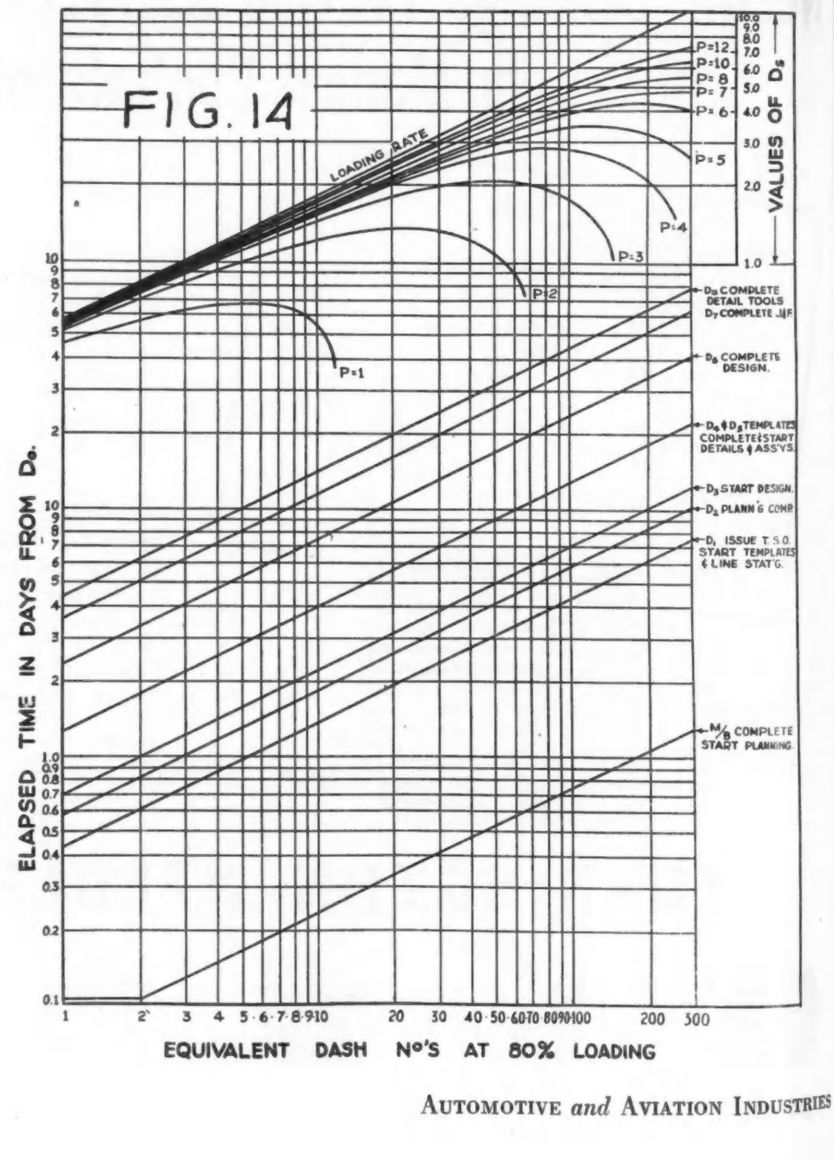
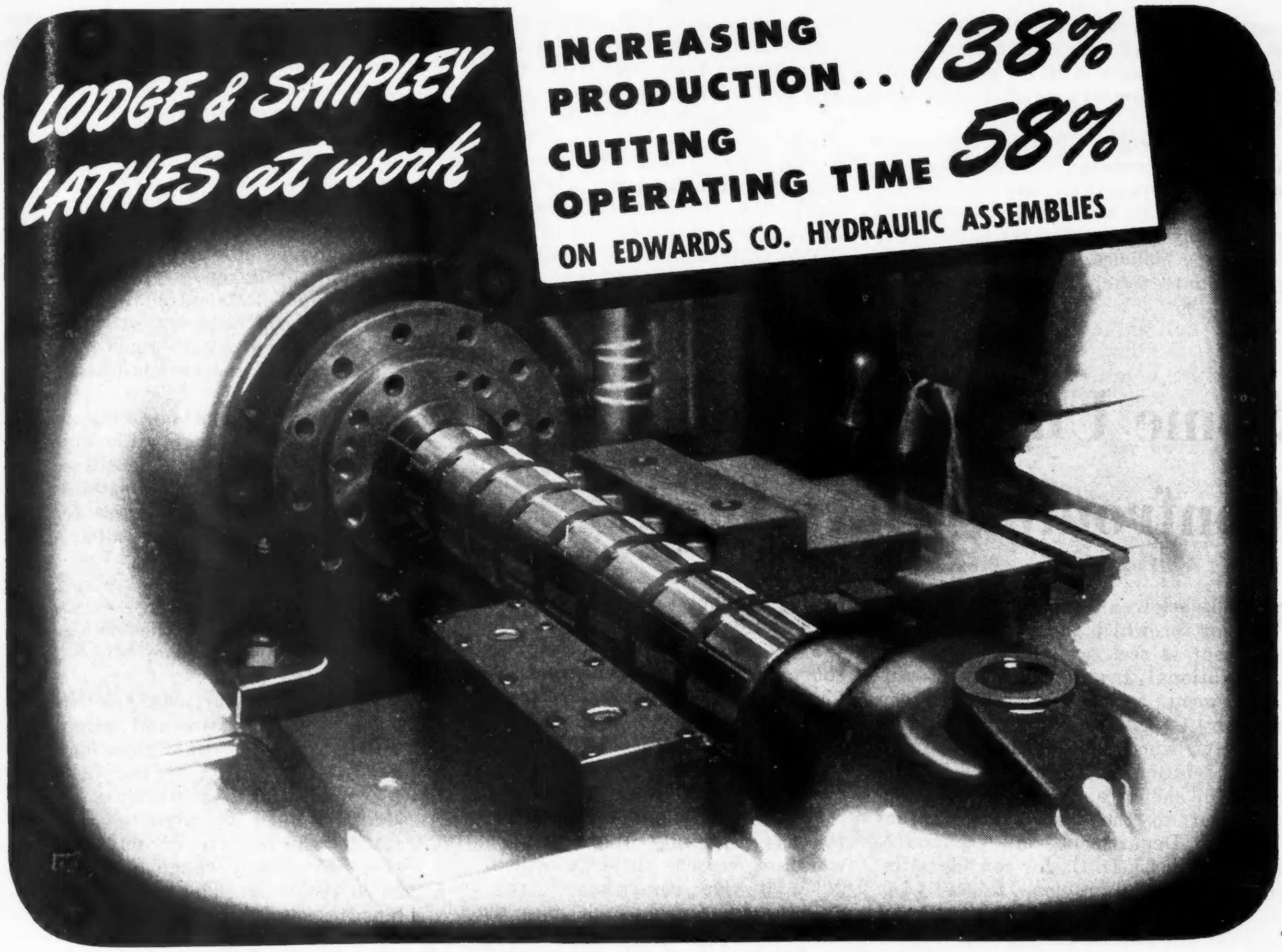
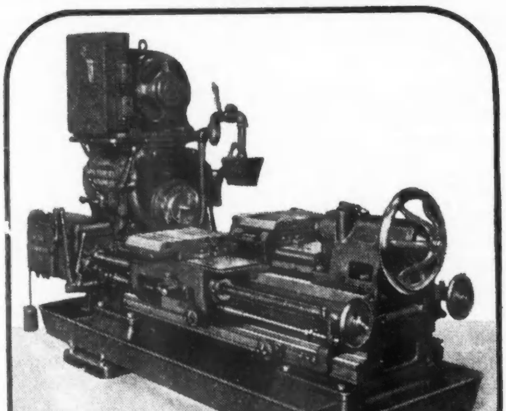


FIG. 14



Do it with a
DUOMATIC



One of the amazing stories typical of the Duomatic's accomplishments is recorded on the production sheets of the Edwards Co., Division of Rogers Diesel and Aircraft Corporation, Sanford, N. C.

The Duomatic—Lodge & Shipley's full automatic lathe—is shown above machining aluminum alloy 24 ST. tubing, the main cylinder for a wing fold strut hydraulic assembly.

Formerly, 8.9 pieces per hour were produced, requiring 6.72 minutes per piece. With the Duomatic, *21.2 pieces are now produced in an hour, requiring only 2.82 minutes per piece.* A 138% gain in production,—58% decrease in operating time!

Dual tool slides and carriages, operated singly or together, make the Duomatic like *two* lathes in *one*. Just one of the many features of this lathe which make possible far greater and better production at lower cost. Call on L & S Engineers for a complete demonstration on your work. For further details on the Duomatic, write on your Company letterhead for Bulletin 601.

THE LODGE & SHIPLEY MACHINE TOOL CO.

CINCINNATI 25, OHIO, U. S. A.

L & S LATHES

ENGINE—TOOL ROOM—AUTOMATIC—OIL COUNTRY LATHES

dash numbers of work in the "mill," the man-hours reserved by one dash number of work will be used up by other dash numbers as they flow into the shops.

The calculation of the standard *M's* is checked reasonably well by the method of proportion and the method of aggregation, but the *M's* can change perceptibly if a major revision occurs in tooling policies. It is advisable to make quarterly check on the values of *M* to make sure that the distribution and elapsed time do not change too radically, and to apply the limit of 10 per cent change to values of *M* as a signal to revision of calculation charts.

The loading and scheduling of job releases is readily accomplished by this method, but considerable sense must be applied to the scheduling of the individual tools within the family of tools created by each job release.

Some Unsolved Problems Confronting Navy Dept.

LISTED below are 25 technical problems for which the U. S. Navy Department is seeking solutions through the National Inventors Council. Announcement to that effect has been made by C. F. Kettering, chairman of the NIC, who requests that any suggested solutions to them should be prepared in sketch and description form, and sent to the National Inventors Council, Department of Commerce, Washington 25, D. C., for consideration and report. The problems follow:

1. *A satisfactory shock-proof aerial delivery container* not requiring a parachute; possibly pneumatic cushioned, the cushions to be inflated from a CO_2 bottle after leaving the plane. Inexpensive enough to warrant its being classed as expendable after being used once.

2. *A beach marker light,* to be visible from 5000 yd out to sea with rechargeable or non-deteriorating battery. Not in excess of 5 lb weight. Effective burning time: 70 hr continuous use, or 7 days of 12 hr on—12 hr off use.

3. *Device for transmitting rotary motion through a moisture-proof barrier —Applications:* Shafts for control knobs on radio equipment provided with immersion-proof case; generator shaft for field telephones equipped with immersion-proof cases; generator shafts for hand-cranked power supplies for field radio equipment; *Characteristics:* Should prevent entrance of water or moisture vapor when immersed to a depth of 10 ft; should offer a minimum of frictional opposition to rotary motion; should be small in relation to the equipments to which applied; should have ample power transmission capability; should be applicable to existing equipment with a minimum of modification.

4. *Waterproof Jack — Applications:* Microphone, headphone and key jacks for telephone equipment; *Characteristics:* Should prevent water or moisture vapor from penetrating equipment, even when immersed to a depth of 10 ft; should be capable of cleaning and drying without tools; should accommodate standard plugs.

5. *A durable plastic-impregnated fabric,* waterproof, lightproof. Weighing less than 6 oz per square foot. Suitable for tentage.

6. *A gasoline resistant coating* for the interior of gasoline drums and not adversely affected by gasoline.

7. *An oil or liquid knapsack sprayer* for use especially in malaria control work in overseas theaters, which, (a) is of simple construction, (b) has easily replaceable and reproducible parts, (c) has a minimum of rubber parts and gaskets, and (d) is light, rugged, durable and leakproof.

8. *Proofing material* which will make tentage and tarpaulin more resistant to the rapid rotting that now occurs in humid, tropical climates.

9. *Directional-Drum Lens:* The Coast Guard uses a large quantity of 200 mm, fresnel type drum lenses on lighted aids to navigation. These lenses provide a 360 deg fan beam of uniform candlepower about the horizon. In many instances the candlepower in a specific direction should be considerably higher than that of the uniform beam. Present practice in such cases is to install an auxiliary "spot" light to increase the intensity in the specific direction. A need exists for a single lens which will permit the function of both of the above lights to be accomplished from a single light source. The lens should have the overall dimensions of the present 200 mm drum lens to permit its being used in the existing housings.

10. *Single Unit Range Light:* A single optical device which will indicate with a reasonable degree of sensitivity a vessel's lateral deviation from the centerline as it proceeds along a narrow channel. Such a device must be inexpensive and low in power consumption. The conventional aid to navigation for such purposes consists of two lights on the prolongation of the centerline separated some distance from each other with the rear light higher than the front. It is in the interests of economy, and also to provide against the fact that the terrain may make the installation of two lights impractical, that this device is needed. Economy involves current consumption and cost of structures. Existing two-light ranges require approximately 50 kwh per year for a candlepower of 10,000 white.

11. *A portable fire extinguisher* using liquid similar to the carbon-tetrachloride (or Pyrene) type, suitable for use around electrical equipment which will not form phosgene or other toxic gas when used to extinguish fires, as is the case with the carbon-tetrachloride extinguishers.

12. *A continuous sampling combustible gas indicator* with automatic alarm which is simple, positive, inexpensive and suitable for installation in gasoline-driven motor boats for continuous sampling of the vapor in the bilges.

13. *A polyphase a-c integral hp motor* up to 50 hp, whose inrush current does not exceed the running current and whose starting torque equals the running torque.

14. *A small portable field strength meter* about the size and weight of a walkie-talkie for rapid checking of radio field intensities in the vicinity of radio transmitting stations. The instrument must be simple to use and accurate within plus or minus 10 per cent. Frequency range desired is 100 kc to 20,000 kc. The range of field intensities desired is from 10 to 1000 millivolts per meter.

15. *Radio antennas* up to 300 ft in height that can be set up by unskilled ground crews. The efficiency of radio devices is often limited by the extreme difficulty of obtaining reasonable antenna heights quickly in the field. Very light alloys and special rigs for rapid erection by a ground crew without climbing are desired, in addition to ability to dismantle or collapse into packages not exceeding 20 ft in length. Insulated base vertical antennas are preferable but grounded base type could be used if the device had enough other advantages in the way of ease of erection and ruggedness.

16. *A cheap and effective barrier* to prevent the propagation of cracks in steel structures, without making use of riveted seams and the caulking, etc., incidental thereto.

17. *A method of welding high pressure piping* without the aid of backing straps or with back straps which would be soluble in a harmless solution which could be introduced in the pipe before putting same into service.

18. *A method of measuring the elastic stresses* locked up in steel or other metallic structures at and beneath the surface of the material without having to dissect the structure in order to record the elastic recovery which results from isolating various segments.

19. *A method of welding light gage aluminum.* (This is of particular interest since aluminum lifeboats and life

(*Turn to page 52, please*)

Effect of German Counter-Attack Being Felt on Our Home Front

Government Officials Are Bringing Industry Back into the Production Fever of the Early War Days

Although the shock of the desperate German counter-attack in Western Europe has been absorbed and the enemy now pushed back to its own borders, the impact of that body blow on the national war effort here at home has stirred repercussions that will be felt in the national economy for many months.

Jarred by the fact that Germany is not yet devoid of plenty of weapons for a desperate and dangerous drive, military and government officials are prepared to be tough and determined in getting the country back into the production fever of the early war days. Of the two major components required for war weapons—men and materials—manpower appears at the moment to be the most critical and is getting the vigorous treatment thought necessary in Washington. The President started off the drive in his message to Congress when he asked for enactment of national service legislation. This has since been followed with various proposed ukases designed to channel workers into essential jobs if they are not already there, and if they are to hold them on the job. Selective Service has stepped into the picture with plans to induct some 200,000 industrial workers between the ages of 26 and 29 into the armed forces, thereby complicating the industrial manpower situation even more.

At this writing, Congress has before it a plan to draft the services of about 4 million men now classified as 4-F. While rather favorably accepted at first, the proposal has since received much cooler reception. Opposition from organized labor to any sort of labor draft has been matched by that of industry leaders. In addition, some lawmakers are questioning the need for such drastic action and are investigating the employment needs and the number of available workers. There is a general feeling that compulsory legislation is not the answer. While this may be true, it certainly cannot be denied that the threat has had an extremely salutary effect on persons not in essential industry. Reports from United States Employment Service offices indicate that they have been swamped with such a landslide of applicants for war jobs that there may be no need for legislation. One large truck manufacturer in the Detroit area says that his plant has had more job applications since the heat has been turned on than it had for many months. WMC in Detroit reports increases as high as 30 per cent in applicants for war work. USES offices in other cities have reported similar or larger gains.

Although there is a clear-cut need for more workers because of the stepped-up war programs, it should be remembered that the need is more qualitative than quantitative. In Detroit, for example, WMC reports that of the 18,000 jobs on file, from 20 to 25 per cent are for skilled workers and a larger unspecified percentage is for heavy labor, both calling for specific rather than general qualifications. In general, the manpower agencies are much more optimistic than they have been for several months about the possibilities of getting the needed manpower into the plants.

Recent figures released by WPB on the increase planned for war production this year show clearly how the picture has changed. The total production program has been upped from the original estimate of $56.5 billion to $64.5 billion. Production of critical aircraft calls for 78,227 planes this year, 2617 more than the estimate made three months ago. This compares with 96,369 planes built during 1944 out of an original projected schedule of 109,000. However, although the total num-

(Turn to page 154, please)

Price Stabilization in the Steel Market Long Overdue

Recent OPA "Interim" Increases Have Not Helped to Rid the Market of Some of Its Artificiality

By W. C. Hirsch

With every pound of steel production immediately needed in the making of war material of one type or another, there is keen disappointment that OPA announcement of "interim" increases of $2 to $5 a ton in ceiling prices of five basic steel items has not in the least helped to rid the market of some of its artificiality. These price changes are the first since 1939, two years before price control went into effect. Even in normal times a lapse of five years necessitates adjustments, based on technical progress and changes in the market picture. With further changes officially promised, the problem is made all the more difficult. An advance of $2 a ton in the price of hot rolled sheets already threatened serious complications. Previous to the advance granted by OPA, No. 19 and No. 22 gauge hot rolled pickled sheets had the same ceiling prices as corresponding gauges of cold rolled. With the hot rolled now $2 a ton higher than cold rolled, a switch by consumers to the latter would be a natural sequel under normal conditions, but the risk of losing advantageous places on rolling mill schedules is likely to act as a deterrent. Mills that buy hot rolled sheets for cold finishing fear that, unless they are granted relief later, they will be at a $2 ton disadvantage.

In releasing publicity on the price changes in the five basic steel descriptions affected, it was emphasized by OPA that these have nothing whatever to do with the wage increases ordered by the War Labor Board in December, but that they are solely the result of OPA studies of steel company reports to the effect that production of these basic steel items meant out-of-pocket losses to them. Whether OPA's plans of further price revision will result in smoothing out more of the war market's rough spots or add to them, only the future can tell. That steel plate for shipbuilding again has an important place in the list of urgently needed war material comes as a keen disappointment to those who had figured on more and more plate mill capacity becoming available for the rolling of other descriptions of flat steel.

Control at all ends of the non-ferrous metal market have been tightened. Settlement of a long standing labor dispute in one of the larger Connecticut Valley brass mills has improved the flow of tubing to consumers. The extremely tight situation in the supply

of aluminum sheets resulted in a WPB order instructing the leading aluminum interest to close order books for the first four months of 1945. Orders on the company's books exceed its anticipated production in the first quarter of 1945. In order to put as much as possible of the Metal Reserve Company's stock pile of secondary aluminum to work, WPB has invited offers from consumers. Continuing paucity in the supply of cadmium is forecast by WPB's Cadmium Industry Advisory Committee. Some relief is looked for as the result of the addition of new source of supply later in the year, but with zinc smelting, from which the major supply of cadmium is derived, hampered by lack of manpower, the outlook for the immediate future is none too bright.

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Resumption of an upward trend of business activity was indicated early in the current year. *The New York Times* index for the week ended Jan. 6 stands at a new peak, 153.9, as against 138.4 for the preceding week and 144.1 a year ago.

Electric power production increased moderately during the week ended Jan. 6 but remained below the corresponding level in 1944, showing a year-to-year estimated decline of 3.1 per cent, as compared with a similar reduction of 2.6 per cent recorded in the preceding week.

Crude oil production in the same period averaged 4,678,550 barrels daily, 27,350 barrels below the figure for the week before and 46,150 barrels less than the output recommended by the Petroleum Administration for War.

Production of soft coal during the week ended Dec. 30 is estimated at 8,310,000 net tons, showing a decline of 23 per cent, chiefly because of holiday observance. Total production in 1944 was 5.1 per cent more than the output in 1943.

Engineering construction contracts awarded during the week ended Jan. 11, according to *Engineering News-Record,* totaled $22,891,000, as against $28,809,000 in the preceding week and $76,180,000 a year ago. Awards for private construction were 25 per cent above the corresponding sum in 1944, but contracts for public work registered a drop of 77 per cent. A decline of 81 per cent in the Federal figure contrasts with a rise of 243 per cent shown for State and municipal construction.

The Irving Fisher weekly index of wholesale commodity prices registered on Jan. 12 the first decline since last September. The recession of 0.1 per cent brought the index to 114.22 per cent of the 1926 average, as against 112.43 a year ago.

Member bank reserve balances increased $136,000,000 during the week ended Jan. 10, with excess reserves remaining at an estimated total of $1,300,000,000. Aggregate loans and investments of reporting members rose $150,000,000 in the preceding week, although the total of commercial, industrial and agricultural loans was reduced by $103,000,000.

PUBLICATIONS

Stow Mfg. Co. has issued a new manual which is intended to serve as a guide in the selection, installation and use of **Flexible shafting** for remote controls for valves and all types of equipment actuated by a rotating shaft. The manual is well illustrated and contains engineering and installation data, specifications, etc.*

A complete **V-belt drive catalog,** with all the required information to make correct drive selections reduced to handy charts, tables and drawings, has been issued by Allis-Chalmers Mfg. Co. The company's new Magic-Grip sheave, designed for fast, easy mounting and dismounting is described in one section, and another covers the Texrope Econograph method of drive selections. List prices, stock sizes, dimensions and construction details are included for all Texrope drives.*

Harco Steel Construction Co., Inc., has published a new HARCO catalog describing nine different types of radio **masts and towers.** Mobile and portable units are illustrated and described as well as permanent installations. A featured item is the exceptionally rigid Bantam King, which lends itself particularly to radar. Guyed and self-supporting, square, triangular and tapered towers are also described.*

Fischer and Porter Co. has issued a new catalog, 92-C, on its **Rotasight.** It is illustrated and describes construction details and applications of the instrument and gives engineering dimensions, flow capacities and prices.*

General Electric Co. has issued a folder, GEA-4140, on **vibration measuring equipment.** Included in the folder are tables showing the range and accuracy of each instrument, illustrations of various types of indicators and a table of specifications.*

A new booklet listing Hercules chemicals, industrial explosives and approximately fifty industries which they serve, has been issued by Hercules Powder Co. An indication of many postwar applications for Hercules chemicals in plastics, paints, textiles, etc. is given in the booklet.*

Shakeproof, Inc., has issued a new folder, **Shakeproof Fastening Application** bulletin which describes and illustrates Sems Fastener Units, a pre-assembled Shakeproof lock washer and screw.*

Pesco Products Co. Div. of Borg-Warner Corp. has issued two new circulars on 1) **Pesco Univac,** a hydraulic brake intensifier for heavy duty service on all types of commercial motor vehicles, and 2) **Pesco Hydrolease,** a hydraulic clutch actuator for trucks, busses, heavy duty motor vehicles and industrial power clutches.*

The Torrington Co., Bantam Bearings Div., has announced a revised Bulletin No. 105, entitled **High Capacity Ball Reciprocating Bearings,** which covers a new list of recommended sizes. The bulletin also gives operating capacities and other pertinent engineering data.*

The Beryllium Corp. has issued a new catalog giving information on the casting characteristics of **beryllium-copper.** The catalog is well illustrated and gives information on the physical properties of some beryllium-copper alloys, recommendations on heat treatment, machining practice, etc.*

* Obtainable by subscribers within the United States through Editorial Dept., AUTOMOTIVE *and* AVIATION INDUSTRIES. In making requests for any of these publications, be sure to give date of the issue in which the announcement appeared, your name and address, company connection and title.

Obituary

L. C. Kenyon, 57, manager of the New York branch office of the Heald Machine Co., died of a heart attack at his home in Summit, N. J., on Jan. 9. Mr. Kenyon had been connected with the Heald Machine Company of Worcester, Mass., since 1918, and had just completed his 25th year as manager of the New York branch of that company.

Howard S. Welch, 51, export sales manager of the Sperry Gyroscope Company died Jan. 11 in Montreal, of injuries suffered when an automobile in which he was riding collided with a street car.

Charles T. Winegar, 66, personnel director for Chrysler Corp., died unexpectedly at Detroit Jan. 13. A graduate of University of Michigan Law College, he practiced law and served one term as a state senator before becoming personnel director of the old Dodge Bros. Corp. in 1916. Upon consolidation of the Dodge firm with Chrysler Corp. in 1929, he was made personnel director of the corporation and held that position until his death. He was active in many civic and industrial groups.

CALENDAR

Conventions and Meetings

Motor & Equipment Wholesalers Assoc., Annual Meeting, Chicago Feb. 26-28

Amer. Soc. for Testing Materials, Pittsburgh Feb. 28

SAE Aeronautic Meeting, New York April 4-6

Midwest Power Conf., Chicago...April 9-10

SAE Transportation and Maintenance Meeting, Pittsburgh May 2-3

Pan - American Aircraft Exposition, Dallas, Texas May 20-27

SAE War Materiel Meeting, Detroit June 4-6

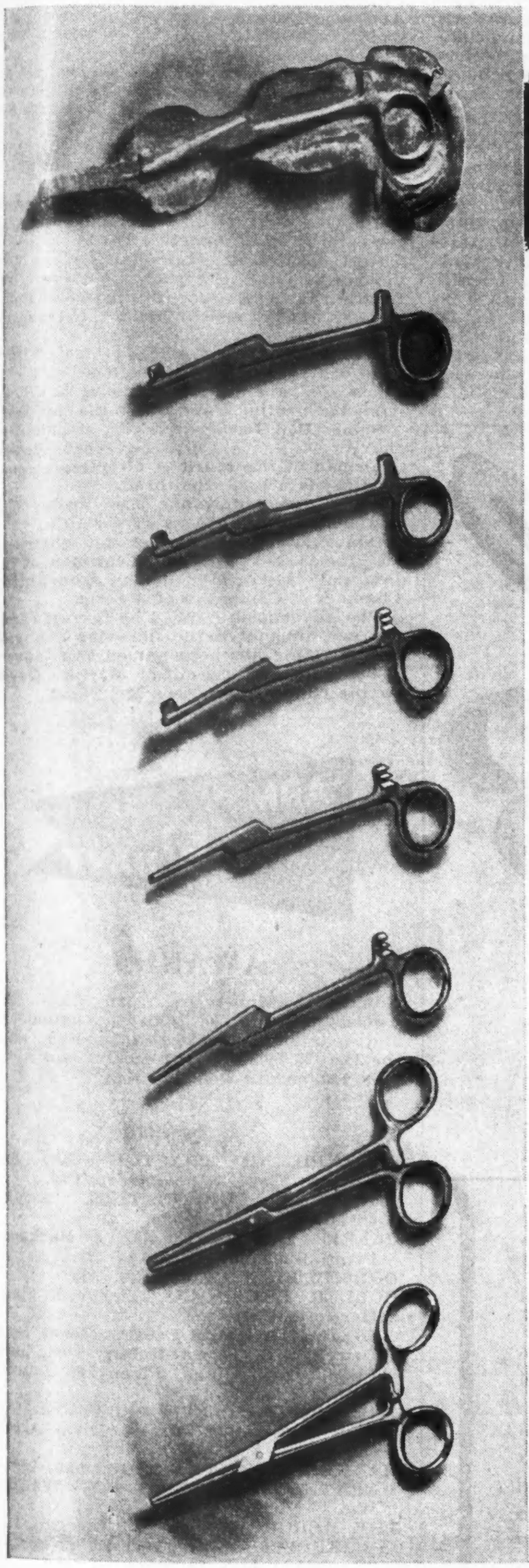
American Society for Testing Materials, Annual Meeting, Buffalo June 18-22

SAE Tractor Meeting, Milwaukee Sept. 12-13

Crawford Elected President of AAPM

Frederick C. Crawford, president of Thompson Products, Inc., has been elected president of Automotive and Aviation Parts Manufacturers, Inc. He succeeds C. C. Carlton, secretary, Motor Wheel Corp., who retired after serving 11 consecutive terms. Other officers elected are: John Airey, president of King-Seeley Corp., vice president, and J. L. Myers, executive vice president of Cleveland Graphite Bronze Co., secretary-treasurer.

Board members elected are W. A. Baker, president of Firestone Steel Products; D. H. Kelly executive vice president of Electric Auto-Lite; and George W. Kennedy, president of Kelsey-Hayes Wheel Co. Divisional directors elected by the board are Crawford, Airey, and Myers, who were re-elected, and Walter Rockwell, president of Timken-Detroit Axle Co. The roster of the association now lists approximately 400 plants in 30 states.



Steps to

Better, Lower Cost Forgings *with* Carpenter Stainless

This Stainless forging job is an excellent example of what is being accomplished every day in modern forge shops. Carpenter supplies the clean, flawless Stainless bar stock from which these and thousands of other forged parts are formed.

Stainless Steel is not difficult to forge if you have forging bars that are free from *seams* and other *injurious surface defects.* All Carpenter Stainless Steel forging bars are rolled from *machine-turned billets.* By thus starting out with a perfect machined surface, we finish up with forging bars that are so free from surface defects that they will frequently forge easily in exactly the same dies that had previously yielded a large percentage of scrap forgings. Never say "it can't be done," or "it costs too much" until you have tried Carpenter's forging bars.

We'd like the opportunity to tell you more about the practical advantages of using Carpenter Stainless for your forged parts. Call in your nearby Carpenter representative, or write us at the mill.

Use Carpenter Stainless Forging Bars for:

◀ Steps in forging Stainless surgical clamps. Uniform, ductile Carpenter Stainless forging bars were used on this job.

- Strong, flawless forgings
- Minimum rejects
- Less die wear
- Lower unit costs

The Carpenter Steel Company • 103 W. Bern Street • Reading, Pa.

Carpenter STAINLESS STEELS

...for
Strength
Rigidity
Heat Resistance
Corrosion Resistance
Longer Product Life
Sales Appeal

BRANCHES AT
Chicago, Cleveland, Detroit, Hartford,
St. Louis, Indianapolis, New York, Philadelphia

PERSONALS

Charles L. Morris has jointed Bendix Helicopter, Inc., as director of field operations.

The Board of Directors of General Motors Corp. elected **Morgan D. Douglas** a vice-president of the corporation. Mr. Douglas was formerly general parts and accessories manager of the Chevrolet Motor Div. and general manager of the General Motors Parts Div.

The Board of Directors of The Metal and Thermit Corp. has elected **F. H. Hirschland** chairman of the board and **Frank J. O'Brien** president. **John B. Tinnon** and **Walton S. Smith** continue as vice presidents. **E. Becher,** first vice-president, has retired.

N. F. Lawler, formerly an account executive with McCann-Erickson, has joined Nash Motors Div. of Nash Kelvinator Corp. as assistant to C. D. Wing, director of advertising and sales promotion. Nash Motors has also announced the appointment of **Floyd G. Sease** as national business manager to replace **J. J. Heilwick,** who has become associated with a Nash and Kelvanator distributor in Denver.

The Meter and Instrument Div., General Electric Co. has announced the following appointments: **Richard Cutts, Jr.,** Manager of Sales, Meter Section; **E. J. Wehrle,** Manager of Sales and **R. H. Mitchell,** Asst. Manager Sales, Electric Instrument Section; and **E. J. Boland,** Manager Sales, Aircraft Instrument Section. The four men will be located at the West Lynn Works. **L. D. Fowler** has been appointed assistant manager of sales, General Electric's Integral-horsepower alternating current motor section, with headquarters in Oakland, Calif.

The appointment of **Charles T. Zaoral** to coordinate the foreign operations of Bendix Aviation Corp. has been announced. Mr. Zaoral has, for the past fifteen years, been associated with General Motors Corp.

The appointment of **R. E. Murbarger** as assistant sales manager has been announced by the Replacement Sales Div., Sealed Power Corp.

Thermoid Co. has announced the appointment of **Fred D. Beecher** as director of automotive replacement sales.

The Sparks-Withington Co. has announced the appointment of **J. T. Templeton** as director of sales, automotive Div.

Morse Chain Div., Borg-Warner Corp. has announced the election of **Walter W. Bertram** as vice-president in charge of sales, and the appointment of **Robert J. Howison** as sales manager.

Clarence F. Alban has been promoted from chief metallurgist to chief engineer of W. M. Chace Co., and **H. D. Matthews** has been named consulting engineer for the company.

Rae F. Bell, former first vice-president of the A. O. Smith Corp. has been elected chairman of the board of directors to succeed the late L. R. Smith.

A. R. Stargardter has been made chief metallurgist of the Ajax Electric Co.

Don Flower has been elected chairman and **James C. Welsch** vice chairman of the Personal Aircraft Council, Aeronautical Chamber of Commerce of America.

The Advertising Dept., The Perfect Circle Co. has announced the following changes: **Robert Bland** has been named asst. advertising mgr., succeeding **Martin Davis.** **Archie Hindman** succeeds Mr. Bland.

ARMY E NAVY

AWARDS

Names of winners of Army-Navy "E" awards in or allied with the automotive and aviation industries announced since the Jan. 15 issue of AUTOMOTIVE *and* AVIATION INDUSTRIES went to press:

E Awards

CATERPILLAR TRACTOR CO., San Leandro Plant, San Leandro, Cal.
CHRYSLER CORPORATION, Amplex Division, Detroit, Mich.
CLARK EQUIPMENT CO., Buchanan Plant, Buchanan, Mich.
DORSEY BROTHERS, Elba, Ala.
FULLER BRUSH CO., Hartford Plant, Hartford, Conn.
GENERAL MOTORS CORP., Fisher Body Detroit Div., Ternstedt Mfg. Div., Main Plant, Div. 3 and Plant 16, Detroit, Mich.
THE GENERAL TIRE & RUBBER CO., Bluff and Union Streets Div., Akron, Ohio.
HAYNES STELLITE CO., Kokomo, Ind.
MARATHON BATTERY CO., Wausau, Wis.
THE MERCURY MFG. CO., Chicago, Ill.
SPARKS-WITHINGTON CO., Plants 1, 2, 3, 4 and 5, Jackson, Mich.
UNITED-CARR FASTENER CORP., Aircraft Parts Div., Binney St. Plant, Cambridge, Mass.
WALTHAM WATCH CO., Waltham, Mass.

★ "E" Star Awards ★

for continuous meritorious services on the production front have been awarded to the following firms:

FEDERAL-MOGUL CORP., Marine Division, Greenville Plant, Greenville, S. C.
THE H. M. HARPER CO., Chicago, Ill.
KOPPERS CO., INC., American Hammered Piston Ring Div., Baltimore, Md.
N. A. WOODWORTH CO., Ferndale, Mich.

THE INDUSTRIAL WEATHER MAP SHOWS

HIGH PRESSURE in the SPLINE & GEAR AREA

Because we foresee a shortage of spline and gear parts during reconversion, we have established a contract department for this sort of work.

Manufacturers of automotive and aviation units, who find that their own facilities are not capable of supplying their assembly lines, may be certain of production on the newest and finest of our spline and gear grinders by men who understand and appreciate the full possibilities and superiorities of their machines.

Fitchburg planning engineers will cooperate with you without obligation. Write to us as soon as you have blueprints.

FITCHBURG GRINDING MACHINE CORP.

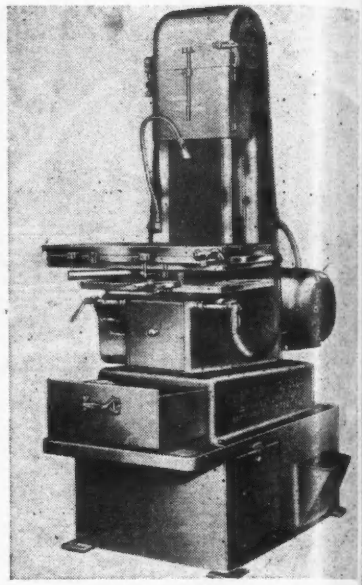
FITCHBURG, MASSACHUSETTS, U. S. A.

Manufacturers of — Bowgage Wheelhead Units. Multiple Precision Grinding Units, Spline Grinders, Cylindrical Grinders, Gear Grinders, Bath Full Universal Grinders and Special Purpose Grinders.

New Production Equipment

PORTER-CABLE MACHINE CO., Syracuse, N. Y., is introducing an entirely new wet belt surfacer with an automatic feed table. The automatic feed table makes the Model BG-8 a high-speed machine tool, capable of cutting operating time considerably, as the operator is free to prepare for the next cycle while the stock is being machined. Hydraulic control and mechanical settings regulate the speed, pressure, finish and size.

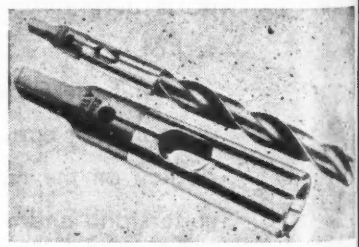
The Model BG-8 is furnished with an individual motor driven recirculating pump system having a tank capacity of 35 gal. This self-contained unit may be used anywhere, independent of water service or drain. The coolant returns to the settling tanks along with the grind-ings. The first tank is a large drawer which traps the grinding or chips. This feature makes it convenient to dump the chips and clean out the surfacer.



Porter-Cable wet belt surfacer

SCULLY-JONES AND CO., Chicago, Ill., are manufacturing a new type drill chuck designed for holding the "Shank-less" high speed drills produced by the Republic Drill and Tool Co. of Chicago.

Only seven sizes of drill chucks ranging from No. 1 to No. 5 Morse taper are required for driving the 135 different sizes of shankless drills, ranging from ¼ in. to 2 in. in diameter. There are seven additional sizes of chucks provided to convert this same range of drills to an "oversize" shank series, thus eliminating the necessity of slee-ing up when larger taper shanks are required.

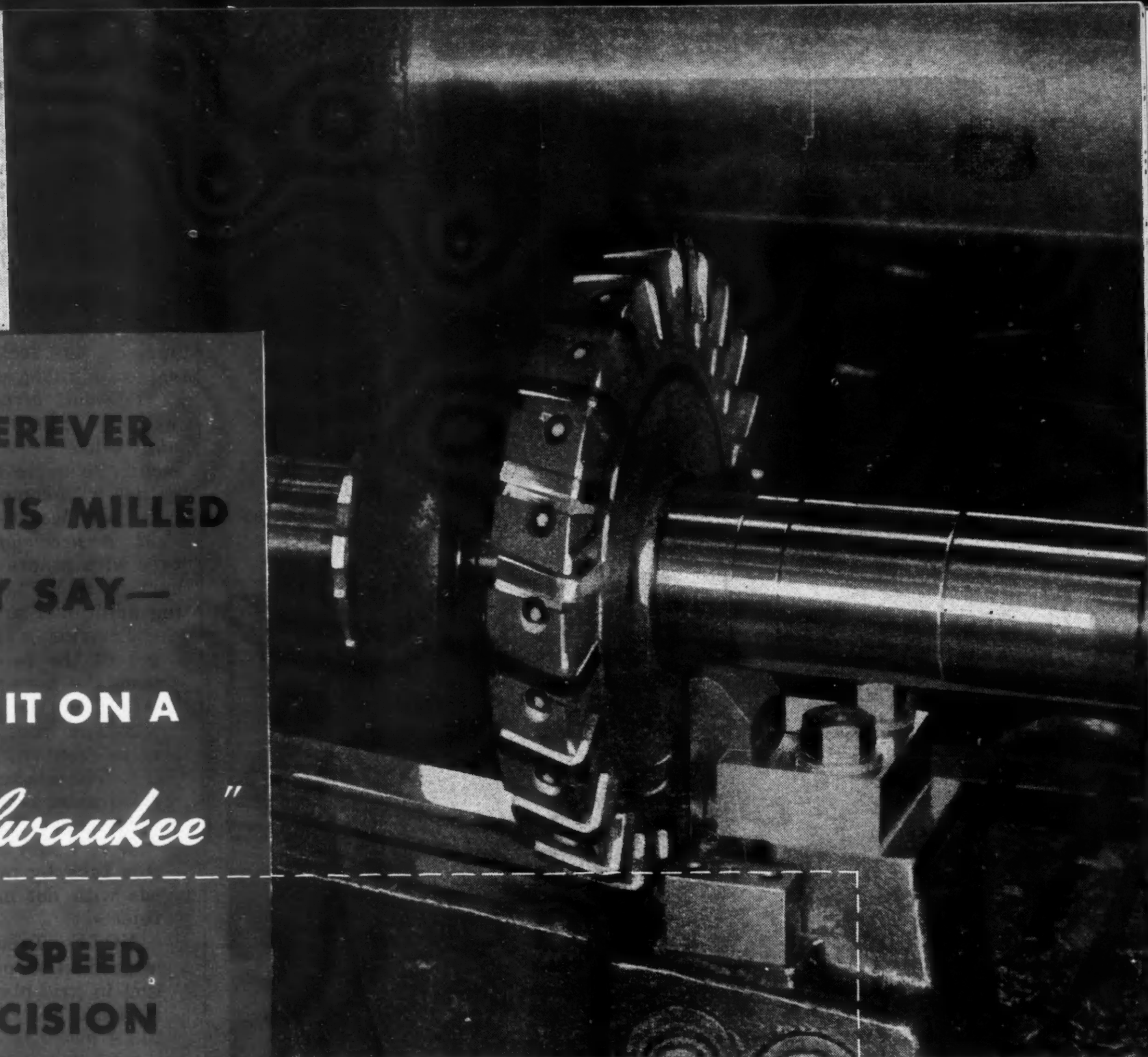


Scully-Jones drill chuck for "Shankless" twist drills

The new Scully chuck is a collet-action driver, designed for driving shank-less drills in any machine having a spindle, holder or attachment with a Morse taper hole.

This chuck is furnished with a Morse taper on the outside and has a straight hole the same diameter and length as the neck of the shankless drill. At the bottom of the hole is a splined section in the form of an elongated slot, with two opposite driving flats. This slot h

(Turn to page 98, please)

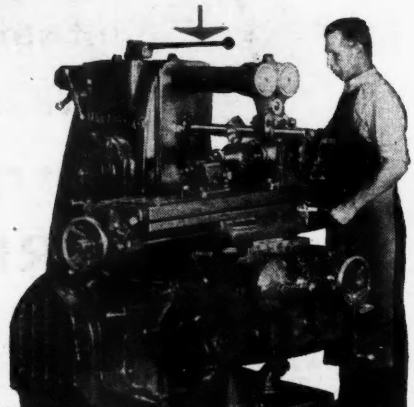


WHEREVER METAL IS MILLED THEY SAY—

"PUT IT ON A *Milwaukee*"

For SPEED PRECISION PROFIT

A special inserted blade side-milling cutter, mounted on a Milwaukee Style B Arbor, is milling this work-piece held in a special fixture clamped to the table of a Milwaukee 3K Milling Machine.



Yes — wherever metal is milled in the tool-room or experimental laboratory, on the production line — Milwaukees rank "tops" as the performers — the machines that get the work done with speed — precision — and profit. In fact when the job is a bit difficult or involved experienced machine-shop men usually say: "Put it on a Milwaukee"!

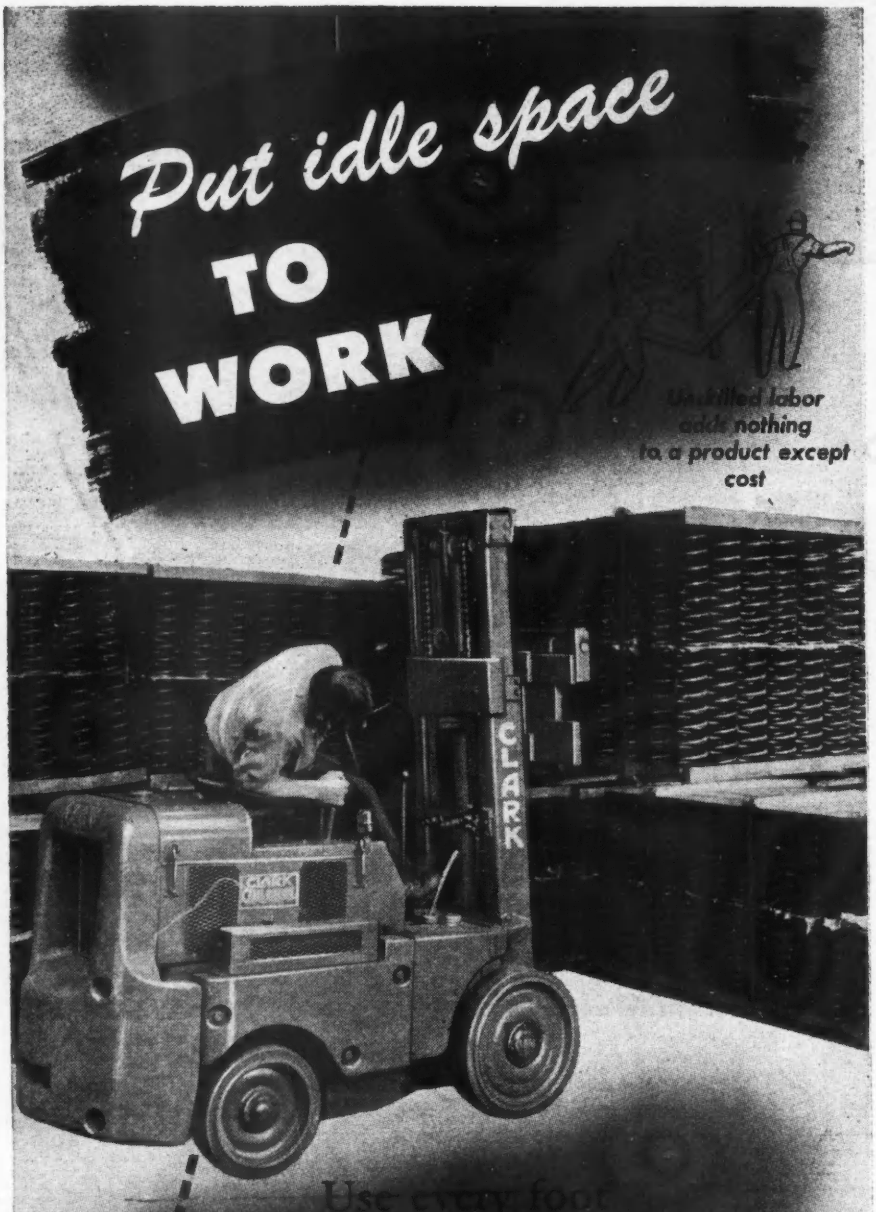
The next time you need milling equipment consult with a Kearney & Trecker field engineer. He will explain why you can effect sustained precision performance through the years with Milwaukee — the powerated milling machines — engineered and built in keeping with their rated motor hp.

Standard models — horizontal, vertical and bed types — in motor ranges 3 to 25 hp; C.S.M. (Carbide Steel Milling) machines 20 to 50 hp; special machines in a wide range of sizes, types, motor hp. *Write for complete information.*

KEARNEY & TRECKER CORPORATION

MILWAUKEE 14, WISCONSIN

Milwaukee Machine Tools



Unsolved Navy Problems

(*Continued from page 44*)

rafts are currently of riveted construction due to the lack of a satisfactory method of welding.)

20. *A "non-slipping" shoe sole* which will give good footing on an oily, steel deck of a ship rolling as much as 17 deg. This shoe sole should be non-injurious to feet, non-sparkling and reasonably long wearing.

21. *Small aircraft type d-c motors* without commutators, slip rings, or any other moving contact arrangements, so as to eliminate service difficulties with commutators and electrical noise produced thereby.

22. *A precision twin-triode vacuum tube* with general characteristics of the current 6SN7 type having the following additional precision features:

   1. After a 15-min warm-up, the gm of the two sides shall be equal over the normal operating range to within +1 per cent.
   2. The tube shall be completely nonmicrophonic.
   3. The above characteristics to be maintained over an ambient temperature range +80 C. to −40 C.
   4. It would be possible to produce this tube by mass production methods with not more than 10 per cent rejects.

   NOTE—Tubes presently available in production permit excessive variation in grid-plate conductance in the separate halves of the tube.

23. *A small Hooke's joint or Universal joint for instrument use,* the efficiency of which is sensibly constant with angularity of output shaft axis up to 10 deg. For above shaft axis angularity units, the Hooke's joint should have an angular velocity ratio of input to output shafts constant and equal to unity over the cycle with as high an efficiency as possible.

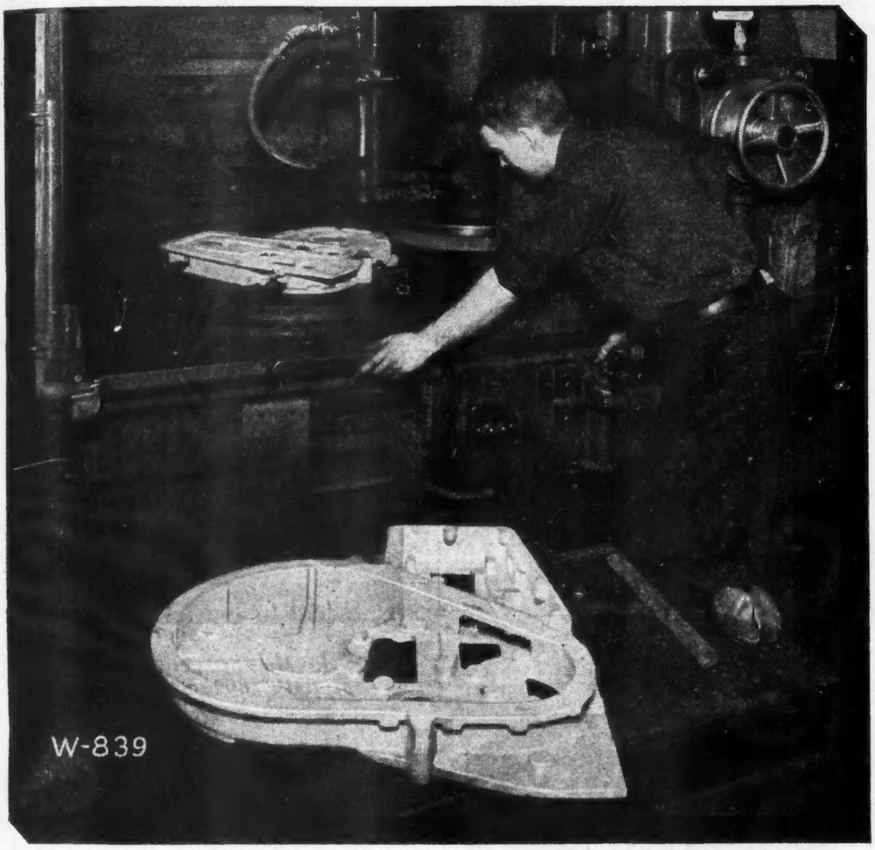
24. *An expendable, compact, lightweight, rugged mechanical device* to permit successive closures of up to eight electrical circuits with a time interval between closures of about 0.2 to 0.3 sec.

25. *A small, fast-acting, double-action solenoid* to operate on 28 volts dc, with a stroke of about 0.5, with a 20-lb pull (or push) at condition of maximum air gap. The plunger should "seat" at each end of travel and would very probably have to be an electromagnet whose polarity would reverse at each end of travel.

Tape Protects Against Fungus Growths

A new fungicide treatment now is used in manufacturing Mystik Self-Stik cloth tape, according to an announcement by Mystik Adhesive Products, Chicago, Ill. This makes possible the protection of shipments and products against fungus growths, which have proved ruinous to many war materials, particularly those shipped to the South Pacific area.

"Put it on the Blanchard"



...GET THESE ADVANTAGES

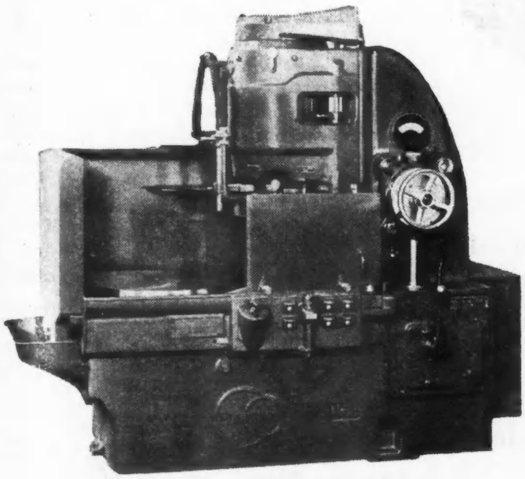
√ Production
Adaptability
√ Fixture Saving
Operation Saving
Material Saving
Fine Finish
√ Flatness
Close Limits

Grinding Aluminum Mounting Plates

Here is another good example of a large but frail piece done on the No. 18 Blanchard Surface Grinder.

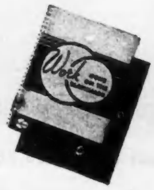
These 23½" x 22" aluminum mounting plates are lightly clamped to a steel base plate on the magnetic chuck. Two pieces (4 surfaces) are ground per hour, removing $^{5}/_{32}$" from each surface.

When surfaces must be flat and parallel, "put it on the Blanchard".



No. 18 BLANCHARD SURFACE GRINDER

Send for your free copy of "Work Done on the Blanchard." This book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.



BLANCHARD

The **BLANCHARD** MACHINE COMPANY
64 STATE STREET, CAMBRIDGE 39, MASS., U. S. A.

German Alloy Cylinder Heads

(*Continued from page 29*)

porosity or drawing. In spite of the close spacing of the fins (see Table I), no sign of "failure to make" was observable.

Chemical Composition and Mechanical Properties

In regard to the chemical analyses (Table II), it is of interest to note that three entirely different alloys had been adopted. For the BMW 132 an alloy of high copper composition was used, while the same manufacturer in the 801 engine had adopted an alloy of the corrosion-resistant type. The Bramo-Fafnir casting was of a material resembling Y-alloy.

The test pieces used to assess the mechanical properties were taken from positions chosen to determine the effect of operating temperatures upon the properties of the material. As the material of the rocker boxes usually suffers only slight deterioration in service, the mechanical properties recorded at this position may be used as a basis for comparison. In Table III are the results of tests on two of the three heads. A Brinell hardness survey on sections of the same two heads was undertaken and the results are shown in Table IV. It was noted that in the BMW 801 head only slight variations in hardness existed throughout each section examined.

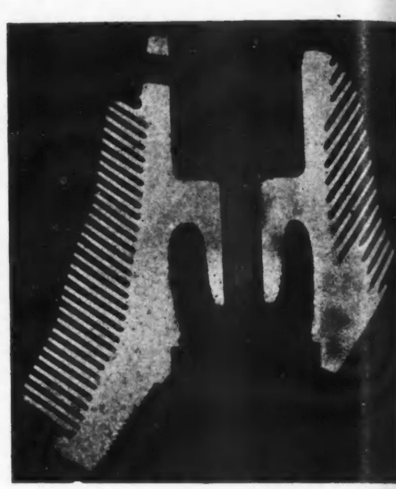


Fig. 4. Macrostructure in section of BMW 801 cylinder head

Macrostructure

The general structure of the castings was observed in etched sections through the rocker box, valve guide and adjacent wall. The three samples varied greatly in general quality and condition. The BMW 132 casting (Fig. 3) showed unusually coarse grain size and long columnar crystals extending from the inner surface. The material was severely affected by gas porosity in the external areas of the wall. The inner zone of columnar crystals, although slightly porous, was not seriously affected in this way and it would seem that precautions had been taken during casting to obtain improved soundness adjacent to the inside surface of the cylinder head.

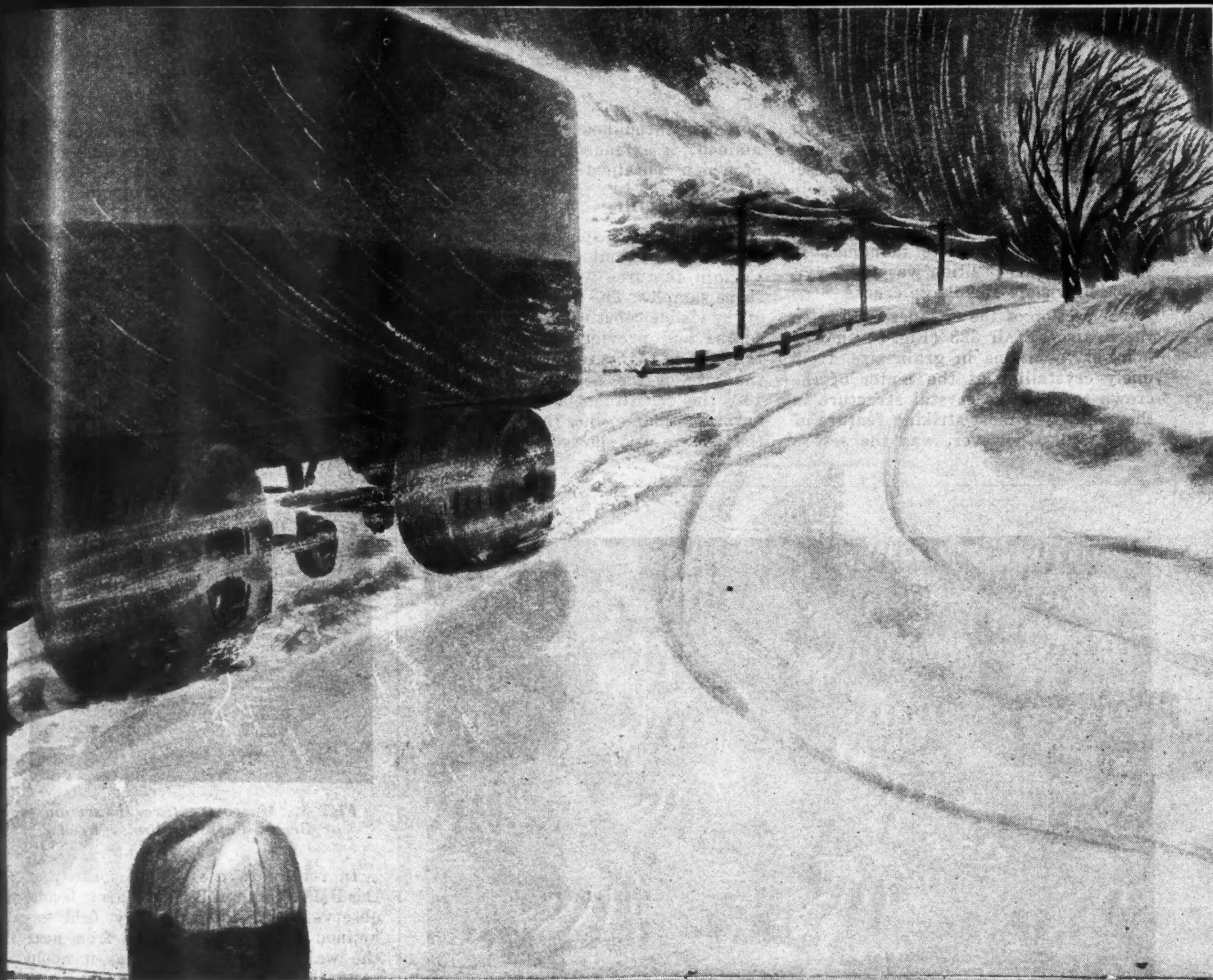
(*Turn to page 58, please*)

Table III—Tension Test Data

Position 1. Rocker box
Position 2. Center of crown
Position 3. Near manifold connection
Position 4. Wall of cylinder head

Engine Type	Position	Yield Point psi*	Ultimate Tensile Strength psi	Elongation Per Cent on 4/A
BMW 801....	1	16,600	23,100	3.0
	2	15,500	17,700	2.0
	3	12,800	18,200	2.5
	4	15,700	19,700	2.5
Bramo-Fafnir 323..	1	....	21,500	1.5
	2	....	17,700	1.0
	3	....	20,000	1.0
	4	....	17,700	1.5

* Approximates to 0.2% proof stress.



SKIDS ON ICY TURNS!

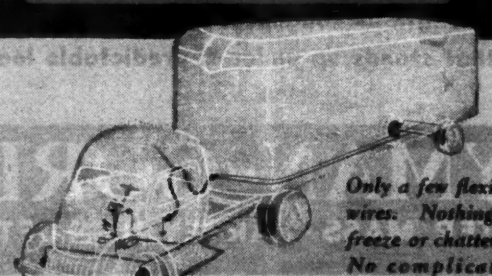
Warner Vari-Load Electric Brakes Assures Greater Safety

fronts low enough so I can steer. I get just the right braking power on all wheels to fit the slippery condition of the road, yet get full use of all the stopping power the road traction will give me. Believe me, that's the way to stay out of front-wheel skids — protect driver and load — and avoid costly tie-ups due to wrecked outfits!"

Right now, the needs of our armed forces come first! Warner Vari-Load Electric Brakes for both tractor and trailer are a postwar development.

BELOIT • WISCONSIN

WARNER ELECTRIC BRAKES



Only a few flexible wires. Nothing to freeze or chatter — No complicated mechanisms.

In the casting from the BMW 801 engine grain size was fine and uniform in character throughout the section (Fig. 4). An obvious feature in this sample was the existence of fine shrinkage cavities in the wall section but apparently complete soundness in the fins. At no position was there evidence of visible shrinkage cracks.

The section of the cylinder head from the Bramo-Fafnir 323 (Fig. 5) showed marked variations in grain size, from finely crystalline at the center of the crown to a coarse crystal structure in the wall. The most striking feature of this casting, however, was the severe porosity throughout each section examined; it extended to the fins, many of which contained severe cracks.

Microstructure

A number of specimens from each head were examined microscopically. Certain features were common to the three samples. The general particle size of the visible constituents was relatively coarse and provided further evidence that the heads were sand castings. In the case of the head from the BMW 132, the constituent network was abnormally coarse, but the casting from the BMW 801 showed a more favorable structure, visible constituents consisting mainly of the magnesium-silicon compound together with a complex aluminum-iron-silicon compound; but the magnesium-aluminum compound was not seen in the as-polished condition. The network of visible constituents in the Bramo-Fafnir casting seemed to be characteristic of Y-alloy.

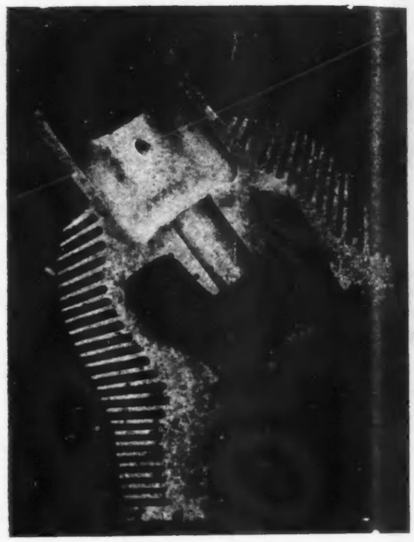


Fig. 5. Macrostructure in section of Bramo-Fafnir cylinder head

In regard to the severe porosity of the BMW 132 and Bramo-Fafnir heads, observable in almost every field examined except in specimens from near the wall, in the latter areas it would seem that the porosity had been controlled, probably by drastic chilling methods. The casting from the BMW 801 also showed a similar contrast in soundness between areas near the inner wall and areas at the center of the wall, but generally this casting seemed to have been produced to a much higher standard of quality. The material at the external surface, including the fins, was reasonably sound.

In general, it may be said that the samples from the BMW 132 and the Bramo-Farnir cannot be regarded as good quality casting, though in neither case was there evidence of any tendency to failure in service. Although the BMW 801 showed a higher degree of soundness it would not conform with the highest standards of quality. Apparently German manufacturers do not aim at high general quality, insisting on soundness only in those parts of the component where freedom from porosity is essential.

Table IV—Cylinder Head Brinell Hardness

Position	BMW 801	Bramo-Fafnir 323
Center of crown	58.0	49.7
Wall adjacent to cylinder	58.0	59.0
Wall of rocker box	61.5	73.0

New Products for Aircraft

Vent Valve Seals Battery Cells When Inverted

An ingenious valve vent which seals the cells of batteries in military aircraft while the plane is flying in a banked or inverted position, yet allows for perfect functioning, has been developed by The Auto-Lite Battery Corporation, Toledo, Ohio.

The valve vent closes to eliminate the danger of spilling corrosive acid while the plane is in any position but normal, and automatically opens the instant the plane returns to a position where the acid cannot escape. Hydrogen and oxygen gases which accumulate while the battery is charging are thus allowed to exhaust without loss of acid.

Remote-Reading Flow Meter for Aircraft

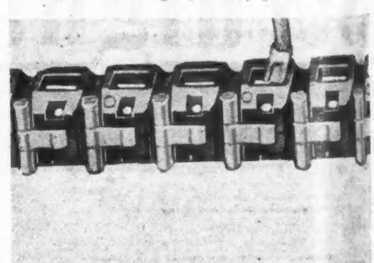
The remote-reading flow meter for aircraft, recently introduced by Fischer & Porter Co., Hatboro, Pa., has no stuffing box nor any friction in the transmission system. Transmission to the remote indicator is completely electrical. Calibration of the prime flow rate measuring element is a straight line and the electrical transmission reproduces this feature in the remote indicator, thus giving evenly spaced scale divisions. The rotameter used for the prime flow rate measurement automatically compensates for variations in viscosity and density in the fluid being metered.

Remote - reading flow meter made by Fischer & Porter

Terminal Block has Self-Locking Feature

Interchangeable with many standard types of AN terminal panels employ-

(*Turn to page 64, please*)



Plastic terminal block made by The Paul Henry Co.

SPEEDING-UP BRAKING TIME

By
A. P. PECK, *Managing Editor*
Scientific American

THE first automobiles had crude braking systems, but in most cases they were ample for the purpose since the chug-chug cars of the early 1900's had little competition on the roads of their day. Soon came the four-wheel brake system and then the hydraulics. But, essentially, tradition was followed despite the obvious need for a still more effective means of stopping cars.

When motor-car production once more gets underway in post-war days and the estimated five-million-new-cars-annually start to roll on our highways, will traffic accidents — the "unavoidable" smacks in stop-and-go traffic and on the open road — climb in like proportion? Or will "power braking," as exemplified by the already available Vacdraulic system, do its part in avoiding these accidents by decreasing the time and distances necessary for stopping cars from a given speed?

In considering the overall subject of motor vehicle braking time — whether truck or passenger car — it must be remembered that two separate and distinct time factors enter the picture. First there is the human reaction time lag between the instant when the driver realizes that he must apply his brakes and the instant when his foot starts to apply enough pressure to the pedal to actuate the braking system. Second, there is the time required for the braking system to bring the car to a stop.

When a vehicle equipped with what are considered today to be "good brakes" is traveling at 30 m.p.h., it will move 33 feet along the highway between the time when the average driver sees trouble ahead and the time when he starts to apply his brakes. But this 33 feet is less than half the story. By the time the vehicle is brought to a full stop, it will have traveled at least another 47 feet or possibly much more!

Here we have a total of at least 80 feet of travel with a vehicle equipped with good brakes before a stop can be made from 30 m.p.h. And a lot can happen in 80 feet in congested traffic!

The figures just cited might be called "ideal" figures. That is, the human reaction time is what might be expected when the driver is fresh, alert, not tired. But when he has been driving for hours his reaction time will increase and, likewise, the pressure which he can apply quickly to the brake pedal will decrease. In other words, the 80-feet stopping distance at 9 a.m. might increase to 110 feet at 4 p.m. after a long day's drive, but without any change in the braking system.

There is not much that can be done about human reaction time itself, but the increased use of power braking, with its accompanying "feather-touch stopability" can compensate for variations by decreasing materially the time lag in the braking system. That is, if the driver has to apply heavy pressure to the pedal in order to produce the required braking action, the total time required to stop the vehicle is increased. Anything that can be done to decrease the needed pressure will also decrease the distance which the vehicle will travel before coming to a stop.

In the Vacdraulic brake power booster, the effective pressure of the foot is multiplied many times. For example — a 50-pound pressure on the pedal is transmitted as 1000 pounds of braking action. Thus, while the human reaction time is not decreased, the application reaction of the booster more than compensates. This brake power booster has no mechanical connections to cause an operating lag or to get out of adjustment. It is connected directly in the hydraulic line and to the intake manifold of the engine. Thus it utilizes the vacuum produced by the engine to multiply the power and stopping energy exerted on the brake drums. In this way it gives to any good hydraulic brake an important factor of increased safety and of split-second stopability.

Brake power boosters, with feather-touch pedal action, are becoming increasingly important on our highways as well as in congested city traffic. They enable a 100-pound high-school girl to exert the same braking action as quickly as a husky 200-pound truck driver. And, furthermore, they make it possible for that same truck driver to keep as complete braking control over his vehicle when he is muscle-weary after a long trip as he could exert when he started out fresh in the morning.

The whole problem of motor vehicle braking may be summed up in this manner: A good braking system remains constant in action regardless of time of day or night or of distance traveled; the reaction time of the driver varies over a wide range determined by physical condition, age, fatigue, excitement, and traffic distractions. The faster a brake will produce the required stopability under a light touch of the foot on the pedal, the safer will be the driver despite his changing reaction time.

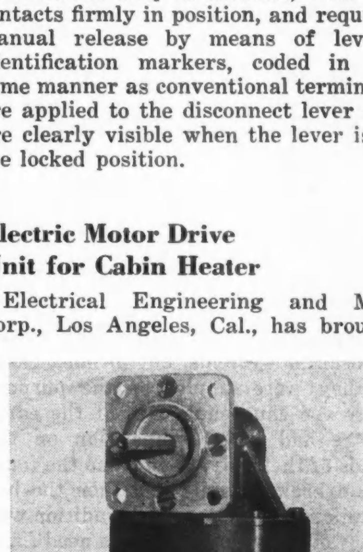
Because of these facts it seems inevitable that brake power boosters will become standard equipment on passenger cars as well as commercial vehicles of all kinds. Perhaps even more important at the moment is that Vacdraulic power boosters can be applied to any pre-war cars equipped with good hydraulic brakes, providing smoother, safer, faster brake action.

ing screw-type fastenings for the lugs interconnecting the desired wires, a new plastic terminal block is announced by The Paul Henry Co., Los Angeles, Cal.

In this terminal block, a cam-action "bridge" element bears against the lugs or terminals to be interconnected, avoiding screw fastening devices. It is not necessary to use wrenches to assemble wires to the terminal panels, and the block may be used in place of disconnect plugs installed primarily to facilitate production speed requirements. A quick self-locking feature provides for snap-in contacts, holds the contacts firmly in position, and requires manual release by means of levers. Identification markers, coded in the same manner as conventional terminals, are applied to the disconnect lever and are clearly visible when the lever is in the locked position.

Electric Motor Drive Unit for Cabin Heater

Electrical Engineering and Mfg. Corp., Los Angeles, Cal., has brought



Electric motor drive unit made by Electrical Engineering and Mfg. Corp.

out a fractional-hp electric motor drive unit specifically designed for cabin heater drive in the Douglas A-26 attack bomber. The ½-hp, continuous-duty type, 7000-rpm motor is equipped with a right angle gear box and drive shaft. It operates on 28 volts and has an overall efficiency of 70 per cent.

French Industrialists And Workers

(*Continued from page* 40)

of the Comités d'Entreprises will be members of the C.G.T. and will follow the political program and the instructions given by that body. The engineers and heads of departments are not likely to have any representation on the new Committees. Even on the permanent staff, composing clerical workers, engineers and heads of departments paid on a monthly and not on an hourly basis, the technical men will be outnumbered by the clericals. It is admitted that the delegates will have to be educated up to their job, and if this is done good results might be obtained. This however, is likely to be a long operation and is not looked upon as a rosy period by the majority of the manufacturers.

One possible effect of the new law is likely to be the splitting up of the industry into small units. One automotive manufacturer stated to me "A few months ago our plans were to double the capacity of our factory immediately after the war. We should have run no risk in doing this, for our line is essential to the industry—in fact we form a bottleneck. Instead, we have decided to start a small factory in which we shall never employ more than 50 hands, and in this way we shall avoid workers' control. We shall make it as efficient as possible by putting in modern machinery, but we feel that under the new law which will inaugurate control from the bottom up, there cannot be the discipline which is necessary in any industrial organization."

Numerous examples are given tending to show the political activity and the individual jealousy behind the present movement. Said one manufacturer: "I learned through a friend at the Ministry that a delegation from by factory had presented a charge against me for excessive zeal in working for the German forces. This delegation occupied four hours of the time of the Minister and high officials. I immediately went to the Ministry to discover that the delegates were men who during the German occupation had been in favor of French workers going to Germany, declaring that it was an excellent opportunity to see another country and to acquire broader experience. I asked for a full inquiry, declaring that if the charges were proved I was prepared to go to prison. If they were not proved the delegation should be imprisoned. The Minister replied that he could not take action against Communists."

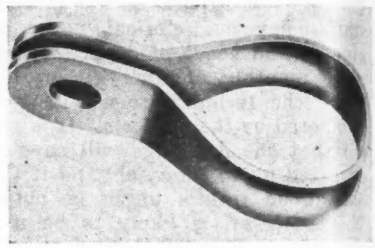
New Products

Filmonize Tape Available Without Priorities

A new line of printed transparent "Filmonize" cellophane tape is now available, without priorities, from the International Plastic Corporation, Morristown, N. J. The tape is clearly transparent and has high tensile strength. A trademark, name, instruction or advertising message may be printed in one line on ½-in. tape, in two lines on ¾-in. tape, and three lines on 1-in. tape. The label may be either 1 in., 1½ in., 2 in., 3 in., or 4 in. in length, including space for "tear-off" between labels. Rolls fit standard dispensers.

Alloy Steel Clevis Ring Produced by Stamping

A new clevis ring that can be produced in a simple stamping operation has been introduced by Poulsen & Narden, Los Angeles, Cal. It is made to exacting dimensions from alloy steel, carefully formed to retain the full strength qualities of the steel. Each ring is cadmium plated, and conforms to specifications ANQQ-P-421.



P & N clevis ring

Tests are said to have shown that the strength factor of this clevis ring is in excess of the cable with which it is used. It fits any standard cable terminal.

G-E Offers New Line Of Demagnetizers

A new line of demagnetizers for completely demagnetizing magnetically soft materials, such as common irons and steels, and partly demagnetizing permanent magnets such as alnico, is now being delivered by the Special Products Division of the General Electric Company. The new demagnetizers are designed to demagnetize tools, drills, and punches in order to prevent excessive heat and wear caused by the adherence of magnetic chips. They are also desirable for demagnetizing various machined parts, thus releasing fine adhering particles which often cause severe wear and impair accuracy and appearance. In addition, they can be used to adjust and stabilize the mag-

G-E demagnetizer

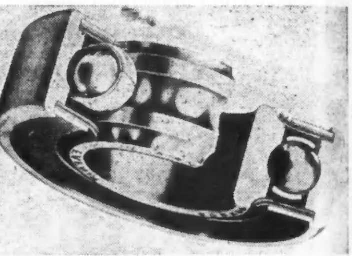
(*Turn to page* 70, *please*)

netic flux in permanent-flux assemblies for such applications as electric instruments and control devices.

Consisting of a cylindrical air-core coil, mounted in a stand at a 45 deg. angle, these demagnetizers are available in a 4-in. size, rated 115 volts, 60 cycles, a-c, and in 8- and 12-in. sizes, rated 220/440 volts.

Bearing Has Diaphragm-Type Contact Seal

The Fafnir Bearing Company, New Britain, Conn., is offering a new type of sealed ball bearing known as "Plya-Seal." The sealing element consists of a diaphragm-type, contact seal comprising two members—a flat, flexible sealing washer of synthetic rubber-impregnated fabric and a split retaining ring of spring steel. The sealing washer does not rotate with the inner ring but is in contact with a ground groove to form an effective seal with a minimum of friction. Due to the minimum space required for the two seal parts, Plya-Seal bearings, except in the extra-small sizes, are held to the same widths as standard unsealed bearings. The Plya-Seal can be easily removed and replaced to allow inspection, washing, and re-greasing of the bearing.

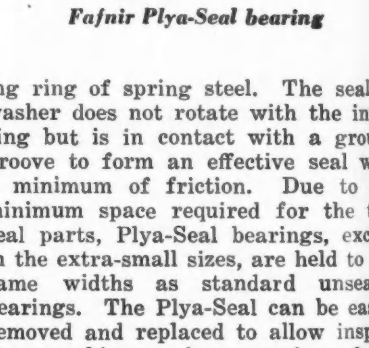


Fafnir Plya-Seal bearing

Protected Type Motor With Surplus Capacity

A motor which combines the surplus capacity of the conventional open motor with protection against dripping liquid, falling chips and other foreign matter, has been brought out by the Crocker-

(*Turn to page 75, please*)



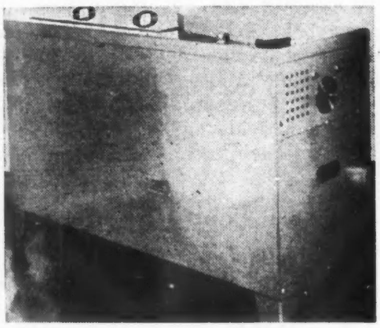
Crocker-Wheeler motor

Wheeler Division of Joshua Hendy Iron Works, Ampere, N. J. At present, these motors are available in sizes up to and including the 284 frame. Mounting dimensions conform to the standards of the National Electrical Manufacturers Association.

There are no openings in the frame or shields above the horizontal center line. This, together with the shielded construction of the ventilating openings, makes protected-type motors suitable for machine tool and similar applications where other types of enclosures have been required in the past.

Small Plastic Coaters

Two small plastic coaters have been designed by the Youngstown Miller Co., Sandusky, Ohio, for melting and maintaining ethyl cellulose and other plastic protective coatings in which parts and tools are dipped. These small units have plastic pumps which provide constant level in the dip tank, and continual removal of surface film and bubbles caused by dipping. In addition, oil jackets the sides and bottom of each tank. Oil and plastics are thermostatically controlled so that the electric heaters are shut off when either reaches its ceiling temperature.



Youngstown Miller plastic coater

Pellets Remove Carbon From Engine Parts

Carboblast, a supplementary treatment for the chemical processes now in use for removing carbon from aircraft, automotive and Diesel engine pistons and other parts is a new development by Turco Products, Inc., Los Angeles, Cal. While prolonged soaking in specialized chemicals is normally required to completely remove tenacious deposits, a comparatively short-time bath now suffices since Carboblast quickly knocks off the residual carbon, oxides and gums. The Carboblast pellets of lignocellulose are softer than any metal used in engine construction and cannot scratch or mar mirror surfaces. Because of this, and by reason of the fact that the pellets are essentially non-adherent as well as

(*Turn to page 76, please*)

smooth and non-abrasive, there is no need to mask off bearings, bronze bushings or plug spark plug holes.

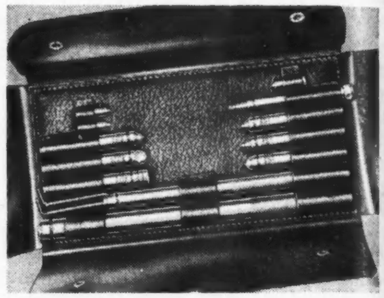
Adhesive for Plywood Cuts Bonding Time

An adhesive which is said to cut bonding and assembly time in hardwood plywood has been added to the line of the Resinous Products & Chemical Co., Philadelphia, Pa. Known as Amberlite PR-245, this resin is a thermosetting phenol formaldehyde in dry powder form which is readily soluble in water, alcohol and mixtures of the two. In bonding either plywood or laminated constructions, the resin is used with catalyst Q-108 to accelerate rate of cure.

Normally, the spread of the liquid Amberlite PR-245 glue in flat plywood may range from 25 to 45 pounds per 1000 square ft of glue line. Either single or double spreading may be employed.

Innovation in Diamond Tool Packaging

An innovation in diamond tool packaging, the new Abrasive general-purpose diamond tool kit, has been placed on the market by the Abrasive Dressing Tool Co., Detroit, Mich. The Abrasive G-P or "jeep" kit, as it is known, contains an assortment of diamond tools to meet practically every requirement of medium-sized and small shops, conveniently presented in a handy, durable, self cover kit. The kit consists of 10 diamond tools, two tool

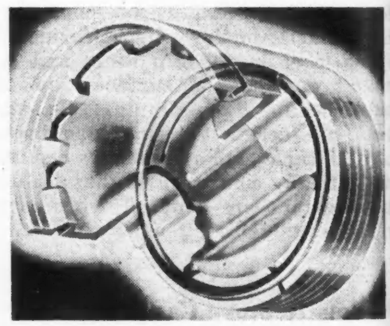


Abrasive G-P kit

holders and two keys for locking tools in the holders. Included are diamond dressing tools, radius tools, cutting tools, phonopoints and a diamond scriber. Each kit bears an identification number and provides a separate compartment for each tool.

Expansion Controlled in New Piston

A new piston with accurate control of thermal expansion has just been announced by The Toledo Steel Products Company, Toledo, Ohio, and is avail-



Toledo Diatrol piston

able through regular channels for installation in all automotive, marine and small aircraft engines. The new piston is called the Toledo Diatrol piston because of the fact that its diameter is controlled.

If the Diatrol piston is a proper fit in the cylinder at room temperature, it will remain a proper fit at every temperature attainable in any engine, according to the maker.


INDIVIDUALLY PENINSULAR ENGINEERED
SINCE 1889
GRINDING WHEELS

American Bosch Self Contained Departments

(*Continued from page* 28)

ings. The aircraft magneto department has specialized facilities for fabricating coils, housings, distributors, rotors, windings, etc.

Precision is the keynote of the entire operation. On fuel injection equipment, such vital parts as, for example, plungers and barrels, and nozzle valves and bodies, etc., are lapped in mated sets to a clearance of one one-thousandths of a millimeter, equivalent to 0.000039 in. When you deal with physical dimensions of this character there is no direct suitable means of mechanical gaging. Accordingly, various indirect means of checking are employed. Typical of these is the use of a pressure test to determine the rate of leakage of air or oil past the clearance space for proving the minute clearance. The exact combination of pressure and flow-rate provides an effective measure of clearance in an assembly such as the valve and nozzle body.

Naturally precision of this order demands maintenance of fine finishes and the control of minute variations in the tolerances of component parts. Accordingly for the Diesel fuel injection system and its parts, American Bosch has self-contained finishing-machining, grinding and lapping facilities. Such parts as plungers, barrels, valves, and nozzle bodies are rough-machined in the general machine division, then routed to these finishing departments, each one of which is equipped with specialized machinery for the desired purpose. The finishing of many of the precision parts actually becomes a hand operation performed by trained operators.

Many operations are handled on small special type grinders, drills, and lappers fitted with toolmakers' microscopes. Lapping of mated pairs of elements is done by hand on special multiple-head lapping machines. Even the fine nozzle spray holes which range from 0.006 to 0.034 in. in diameter are hand lapped. These holes are drilled, burred, and then lapped after hardening with selected wires honed to size before using.

Owing to the enormous variety of operations performed in the various departments, it is impossible to do full justice to their manufacturing achievements at this time. It is of interest, however, to comment on an outstanding feature of the manufacture of aircraft magnetos. They are assembled in their specialized department, then submitted for a run-in test on stands for 11 hours. Following this "green" run, the magnetos are routed to another department where they are disassembled for inspection of each component part. When these parts pass rigid inspection, the magnetos are reassembled and retested to Army-Navy specifications for

(*Turn to page* 82, *please*)

performance and are then acceptable for shipment for fighting aircraft flown all over the world. It may be noted that this procedure parallels the final steps in the manufacture and testing of military aircraft engines.

A sampling of some of the items of equipment shows that American Bosch Corp. has taken full advantage of modern machine tools which are familiar throughout the automotive industry. Among these are: vertical type Micromatic honing machines; Cincinnati vertical Duplex Hydro-Broach machines; Cincinnati mills; Norton grinders; Brown & Sharpe grinders; Heald Bore-Matics and internal grinders; Ex-Cell-O precision boring machines; Landis hydraulic grinders; Norton Cam-O-Matics for grinding camshafts; Warner & Swasey heavy duty turret lathes; several Bullard Mult-Au-Matics; Brown & Sharpe automatics; National-Acme Gridley automatics; and a variety of makes and types of single- and multiple-spindle drills. The precise sizing of fine bores is determined by air gages, including the familiar Airex and Sheffield Precisionaire units.

For a better visualization of the steps in the manufacture of precision parts, we have selected a number of interesting items which are covered in detail in the following paragraphs.

NOZZLE VALVE — This routing provides the sequence of major operations in the finishing stages, starting with pieces produced on screw machines:

OPERATION AND EQUIPMENT

Preheat to 1330-1380 F—Hayes preheat furnace.
Heat to 2160-2190 F and quench in oil—Hayes high heat furnace.
Temper for 15 min. at 570 F—Homo tempering furnace.
Boil in soda water—Wash tank.
Rough & finish grind OD (2 passes)—Cincinnati centerless grinder.
Inspect hardness 100 per cent—Rockwell.
Grind 60 deg center point on spray pintle—Special cyl. precision grinder.
Grind 60 deg center point on valve stem—Special cyl. precision grinder.
Grind valve stem diameter—Brown & Sharpe #5 or #1 grinder.
Rough grind valve seat dia. & 60 deg taper—Special cyl. precision grinder.
Rough grind spray pintle diam. & grind

(*Turn to page 85, please*)

shoulder—Special cyl. precision grinder.
Finish grind spray pintle diam.—Special cyl. precision grinder.
Finish grind valve seat diam. & 60 deg taper semi-finish grind OD—Special precision grinder.
Rough grind valve seat 60 deg—Special cyl. precision grinder.
Finish grind OD—No. 5 Brown & Sharpe grinder.
Finish grind valve seat—Special cyl precision grinder.
Lap OD of nozzle valve, wash, check OD & assort trays according to size—Norton No. 10-U rotary lapping machine.

PINTLE TYPE NOZZLE BODY—This is an intricately formed part. The routing given below shows the multiplicity of operations involved in the formation, grinding and lapping of the valve seat and the nozzle body. The valve hole is finished by rough and finished lapping.

OPERATION AND EQUIPMENT

Spot valve seat 90 deg, finish countersink 60 deg recess, spot spray hole 60 deg, drill spray hole, semi-finish countersink valve seat, counterbore spray hole, finish countersink valve seat—Cataract bench lathe.
Roll in inscription & date symbol into head of nozzle body—Martin marking machine.
Carburize for 3 hours at 1650 F, decrease heat to 1450 F, quench in oil from 1450 F—Homocarb furnace.
Wash in kerosene, wash in hot Oakite, rinse in boiling water—Wash tanks.
Temper for 2 hours at 350 F—Homotemp furnace.
Check Rockwell hardness 100 per cent—Rockwell tester.
Inspect fuel entrance holes 100 per cent—Bench.
Rough lap nozzle valve hole—Lapping motor.
Finish lap nozzle valve hole—Lapping motor.
Inspect nozzle valve hole 100 per cent—Bench.
Lap valve seat, wash in gas & blow out—Semi-automatic lapping machine.
Check concentricity, check valve seat depth before and after lapping.
Grind bottom face, grind top face—Blanchard grinder.
Grind spray hole—Special grinder.
Burr edges on top face with oilstone—Lapping motor.
Demagnetize—Demagnetizer.
Lap top face—Precision speed lathe.
Inspection is made at required points during the processing.

PINTLE NOZZLE ASSEMBLY—A drawing of the assembly is shown here to assist in following the individual steps involved in the selective fitting of valves and bodies and in their mutual

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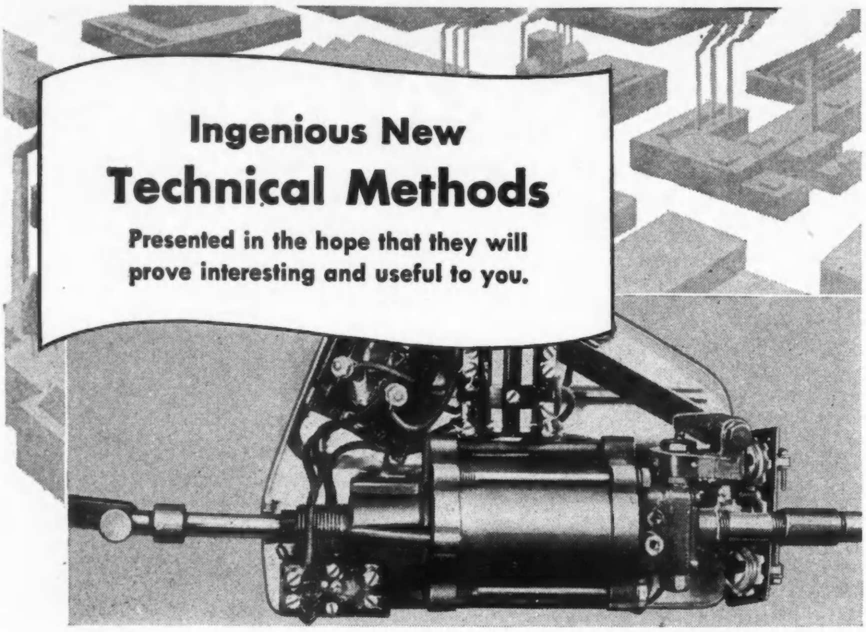
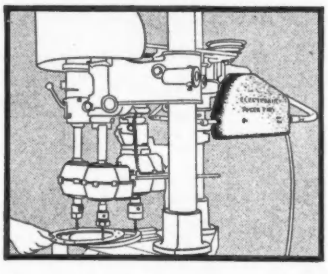


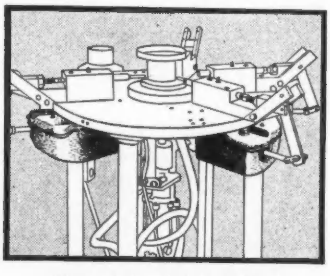
New Electroaire Power Unit Converts Standard Drill Press to Automatic

This exact control over feed and retraction speeds permits ready conversion of a standard drill press with tapping head into an automatic tapping machine, capable of producing Class III threads, even with comparatively unskilled operators. By adjusting speed to conform to the lead pitch of the threads being tapped, the tap will cut without forcing threads, and on the reverse the tap will actually "float" out of the part with no strain against the thread angle.

Air-powered jigs and fixtures can be opened, closed, and indexed by the Electroaire Power Feed. The unit can be set for a pre-determined number of cycles so that multiple holes can be drilled in the same piece without ejection, by means of an indexing fixture controlled and synchronized by the Electroaire Unit. One operator can run as many as two or three drill presses, turning out top-quality work with few rejects and with a minimum of tool breakage, thus effecting a great savings in time.

Present stockpiles of finest quality materials used in the manufacture of Wrigley's Spearmint chewing gum are now exhausted—necessitating discontinuance of production. When a supply of proven materials—known to be up to the finest standards of quality—is again available, Wrigley's will resume production—And Wrigley's Spearmint will be back to again help you on your job. In the meantime they are manufacturing a war brand. Wholesome but not excellent enough for the Wrigley brand name.


Set up to punch 3 holes simultaneously


Shows holes being drilled automatically

You can get complete information from Electroline Manufacturing Company, 1975 East 61st Street, Cleveland 3, Ohio

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Technical Subjects at SAE War Meeting

(*Continued from page* 17)

plied by designers and operators.

On several occasions during the year 1944 Captain Lisle F. Small, U.S.N., of the Bureau of Ships exhorted the Society and its members to devote some extraordinary attention to the problem of torsional vibration in engines. Two contributions to this end were found at this meeting. One is an exhaustive treatise on the methods for calculating torsional vibration by F. P. Porter, Fairbanks, Morse & Co., builders of larger Diesel engines. Because of its scope the paper cannot be summarized here and we shall be content with a statement by the author as to his objective—"to review and describe the calculating procedure for computing the natural frequencies, peak amplitudes, and forced vibrations using either the Holzer table or the reduction method."

As a corollary to the Porter paper, T. H. Pierce presented a comprehensive treatment of the design of bonded rubber torsional vibration dampers for Diesel engines. The author's analysis proves beyond a doubt that the damper is not a mass-production accessory, but a scientifically developed mechanism, tailored not only to the specific needs of an individual engine but to a unique application of that engine. It is of interest to find that in considering the design of a rubber bonded damper it is necessary to analyze the power plant to determine the natural frequency of the entire system. In some instances the damper designer has been instrumental in recommending certain changes which tend to shift the objectionable high amplitude torsional periods beyond the maximum operating range of the engine. Generally, however, such changes cannot be made and a damper must be applied. The paper describes the approach to the analysis and solution of a number of specific problems and gives the design details of a unique damper which was installed as a part of the flywheel mass.

Williams and Miller, Pratt & Whit-

(*Turn to page* 88, *please*)

ney Div., United Aircraft Corp., contributed a study of the primary balancing of radial engines, concluding that the conventional method of analysis is incorrect because of improper division between reciprocating and rotating weights. They submit, however, that the formula found by Professor Coppens gives the correct answer when using the incorrect method of analysis. They recommend the graphical method which does give correct balance within the limitations of accuracy of any graphical method.

Current consideration of the gas turbine as a contender in the field of internal combustion engines is high-lighted by the paper "Some Possibilities of Turbine Compounding with the Piston Engine" by C. F. Bachle. The discussion centers about the use of the turbosupercharger or gas turbine combined with a piston engine to utilize the exhaust gas energy. The turbosupercharger is credited with an impressive war record as a means of improving altitude performance. The author considers the role of the gas turbine chiefly for aircraft applications, but his analysis may well be extended to the peacetime development of gasoline and Diesel powerplants for ground vehicles, utilizing the gas turbine as means of improving overall efficiency and power-to-weight ratio.

While on the subject of engines, it is of interest to note that development work and field testing are being conducted on a passenger car engine redesigned for the maximum use of aluminum alloys for the major structural elements. Progress of this work should be followed with keen interest.

Power steering for heavy duty vehicles has been the subject for speculation for many years. As with other developments of this character, the exigency of the war accelerated development by many years and has laid the ground work for applications to vehicles for civilian pursuits. A survey of power steering for automotive vehicles was reported by Francis W. Davis, who concluded that power steering offers a new tool with which to provide ease of control and reduction in driving hazards. Power Steering de-

(*Turn to page 90, please*)

vices are classed in two major types—pneumatic and hydraulic. These are available either in self-contained systems or booster systems which can be applied to an existing vehicle. At the present writing the consensus appears to be that power steering is most adaptable, from a cost standpoint, to heavy duty vehicles such as heavy motor trucks, large buses, and off the road vehicles. Here is a development of unusual interest to automotive designers. Doubtless the application of power steering will be subject to the same economic laws which control the utilization of all other elements of motor vehicles.

On the production side of the meeting we find two papers—"Tocco Hardening" by H. B. Osborn, Jr., and "Induction Heat Treatment of Internal Surfaces" by H. E. Somes. The first paper provides an illuminating picture of the spread of induction heating to the local and selective hardening of a large variety of automotive parts, heating of parts for forging or brazing, etc. From this one may visualize an ever-widening field of application after the war. The second paper deals entirely with the specialized techniques for the hardening of internal surfaces such as the bores of cylinder sleeves and the barrels in cylinder blocks, and the hardening of bearing surfaces in parts such as wheel hubs, thereby eliminating inserted bearing races. Both papers are valuable in charting the range of useful applications as well as the present limitations of the processes.

Solid food for thought is found in "Some Cases for Steel as a Material" by E. P. Strothman. His thesis is that the designer is limited in his choice of structural materials by the production methods at hand and by a circumscribed knowledge of production techniques. In developing this point, the author shows how the manufacturing specialist familiar with unique methods of fabrication frequently can be instrumental in achieving a revolution in design. The presentation is made dramatic by citing actual cases in which the A. O. Smith organization, with its background of experience in special stamping techniques, welding, and

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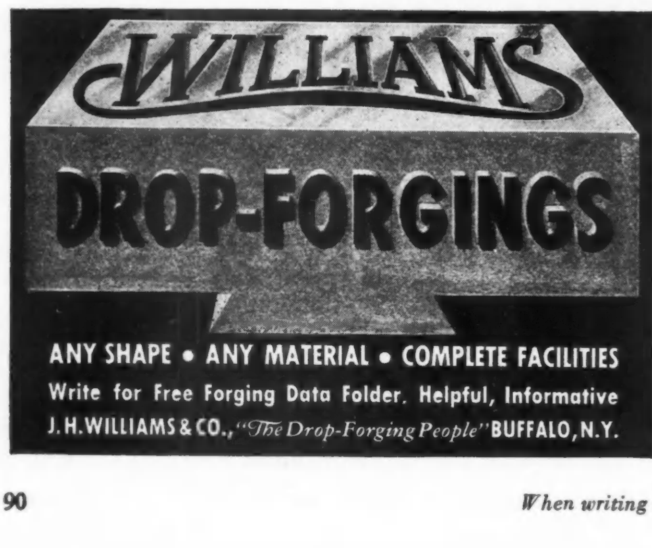

mass-production fabrication methods have found it possible to redesign vital airframe elements so as to use steel stampings instead of non-ferrous castings. Easily the most dramatic case is that of the B-29 nose frame, originally produced as a thin-section magnesium alloy casting. A. O. Smith succeeded in producing a welded pressformed alloy steel frame of equal weight, but structurally even stronger, easier to produce and at lower cost. Such special skills needs must be a factor in the postwar era in establishing the economic role for the various materials competing for position in the products of the automotive industry.

Little comfort is found in the exceptionally fine study made by the Ordnance Department of the metallurgy of foreign automotive materiel as presented by Colonel J. H. Frye. This paper describes the metallurgical situation both in Germany and in Japan and describes in excellent detail the chemical analysis and heat treatment of captured enemy equipment including—the volkswagen, 8-ton half-track and personnel carrier, heavy duty engine and transmission. The conclusions bring no comfort to people who may have a misguided notion of things as they are. According to Colonel Frye, German metallurgical practices are efficient and advanced. Forging is employed extensively as a means of fabricating, the Germans being particularly adept at the hot pressing of both ferrous and non-ferrous castings to improve the structure of the metal. Heat treating practices are in a highly developed state and compare favorably with those in this country.

C. A. Gladman, scientific officer, National Physical Laboratory, England, made the long trip across the Atlantic to present a proposed standard on drafting room practice for interchangeable components. It is hoped that this report will be widely circulated and considered studiously in the interest of furthering the art as well as international standardization.

We reserved for the end what might have been one of the "hottest" sessions of the meeting were it not for the

(*Turn to page 96, please*)

fact that the war is far from being over. We refer to the session on the practical postwar car, symposium based upon consumer reaction to present automobile bodies. Four newspapers, of national reputation, made the survey of their readers by various means. Only two of the reports were presented in statistical form and even these may not satisfy the requirements of statistical analysis. Nevertheless, the trend of the survey was most instructive. It showed first that among car owners there is an appreciation of safety and comfort and economy of operation. Generally speaking, and again without clear cut statistical proof, the majority of the samples were in favor of bodies with more visibility rather than lower streamlined forms. These people want to be able to see their fenders and gage the width of the car; they want to see immediately ahead. The survey agreed with the comments made by John Oswald that electroplated parts and painted sheet metal parts have not stood up in long service. They want better rust-proofing of sheet metal and are willing to settle for less and less bright work and gadgetry.

The passenger car activity of the SAE initiated the survey and will know what to do with the results. It would be interesting to hear from "Buck" Weaver, GM's customer research specialist, as to the validity of the sampling and how the survey compares with the splendid studies that have been made by General Motors.

Two Plants of Chrysler Corp. Producing Rockets

Up to the first of this year, the Dodge and Highland Park plants of the Chrysler Corp. produced more than 150,000 rockets for use in the Pacific and European war theaters, according to a company announcement.

The Dodge Div. has been in volume production of the shell nose and burster tube for several months. The body of the shell is built at the Highland Park plant, where fins are assembled to the body and the tube assembled to the shell.

America's Leading Buses—

SPICER EQUIPPED

A large percentage of America's buses, carrying millions of passengers over millions of miles of city and country highways, is equipped with Spicer Products. Spicer Transmissions, Torque Converters, Clutches, Propeller Shafts, Universal Joints and Axles have established an exceptional record of performance in serving America during both peace and war. Spicer Manufacturing Corporation, Toledo, Ohio.

42 YEARS OF
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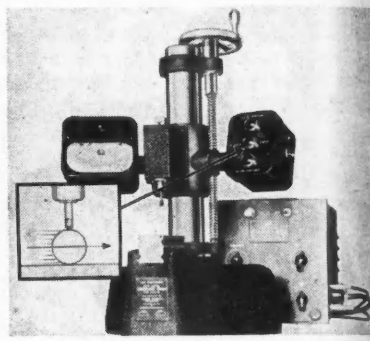
Southern Coach And Body Company
BEAVER METROPOLITAN COACH
AEROCOACH
TRAVEL AND SLEEP IN PULLMAN SAFETY AND COMFORT
White
General Motors Coaches

New Production Equipment

(*Continued from page* 50)

an opening that permits the tang of the shankless drill to enter and engage the driving flats, thereby assuring a positive drive.

FEDERAL PRODUCTS CORP., Providence, R. I., has placed on the market the Federal Model 130 Foote, Pierson Electronic gage, an instrument which is provided with both indicator dial and limit lights. The indicator dial may be used to determne variations from specified tolerance, and to select workpieces



Federal electronic gage

according to their dimensional variations. It is used also when setting the gage. The limit lights provide a rapid means of inspection; green is O.K., red is oversize and yellow is undersize.

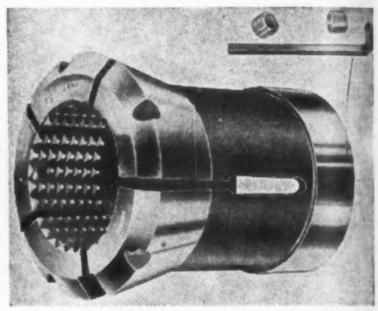
THE Sundstrand Machine Tool Co. of Rockford, Ill., has designed and built a special machine for milling the circular, partial and dome fins on a forged aluminum airplane cylinder head. This one machine will handle in two operations the milling of the same number of fins which formerly required four machines and four separate operations. Actually, the milling of the circular and partial fins is done in one operation. The milling of the dome fins requires a change in the cams, the cutter and the work-holding fixture.

The machine has a combination of

(*Turn to page* 100, *please*)

electronic and hydraulic control. One of the features is the arrangement for controlling the cutter load. The path followed by the cutter is very irregular and constantly changing in shape and depth for each successive fin. With the automatic electronic feed control provided, the fragile cutter is kept loaded to full capacity. If the cut becomes light, the rate of feed increases, and if the cut becomes heavy, the rate of feed decreases. The rate of feed varies automatically within a range of 6 in. to 60 in. per minute with the actual rate depending upon the depth of cut and hp consumed.

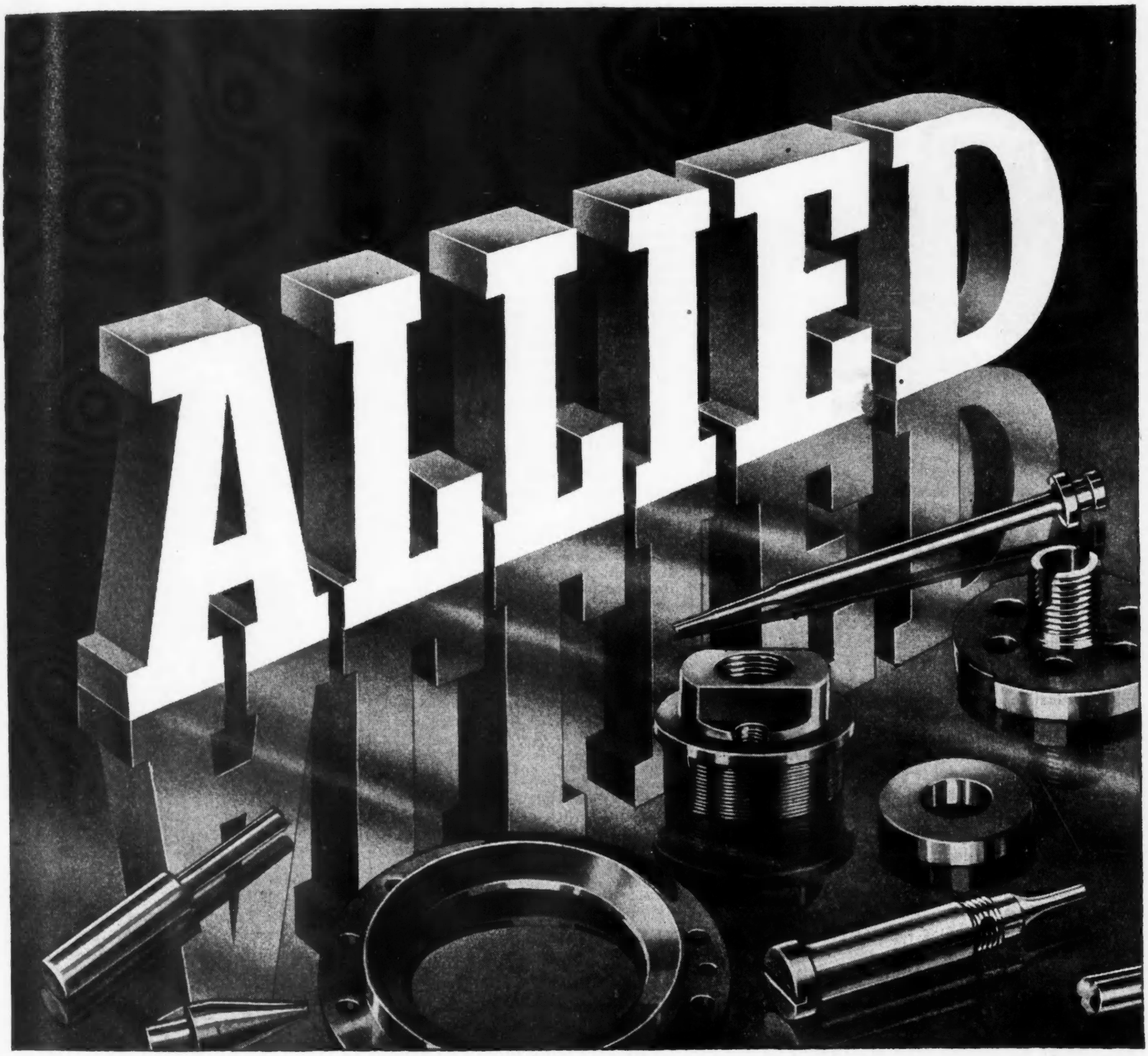
A COLLET that incorporates, in each serrated section, a "cup-point" lug which penetrates the stock slightly with the collet in the locked position, is manufactured by the Sheffer Collet Company, Traverse City, Mich., and identified to the trade as "Super Grip."



Super Grip collet

Lugs are usually set .010 in. to .015 in. above regular serrations. They can be adjusted for more or less penetration, or can be turned away completely, leaving effective only the standard serrations, without removing the collet from the machine.

Every Day There Is a Chance to Do Something for Our Fighting Men. Let's Do It



Buy More War Bonds

... An Ideal of Quality reflected in a Name

For years the divisions of Allied Products Corporation have held proudly to an ideal of quality. Through two wars its craftsmen have produced the finest in precise production tools.

Because of this ideal, Allied has become a standard source of supply for many mass production industries. Now, because of wartime expansion, Allied is equipped to serve more manufacturers than ever before. Anticipate your postwar requirements and start now to profit by Allied's years of experience and exceptional facilities. A good beginning is to check your supply problems with Allied. Send blueprints for estimates or write today.

"IT'S AN ALLIED PRODUCT" **. . . Allied Products Corporation and its divisions, Richard Brothers and Victor-Peninsular, in Detroit and Hillsdale, Michigan, make: cold forged parts, hardened and precision ground parts, cap screws, sheet metal dies (from the largest to the smallest), R-B interchangeable punches and dies, steam-heated plastic molds, jigs and fixtures and special production tools.**

ALLIED PRODUCTS
CORPORATION

Department 18, 4610 Lawton Avenue, Detroit 8, Michigan

American Bosch Self Contained Departments

(Continued from page 85)

finishing operations. The major steps in preparing a nozzle assembly are outlined below:

Lap spray hole to partial clearance. Holes must be round, smooth, concentric, and to size. Gaging must be done carefully in order not to damage spray hole.
Inspect spray holes for partial clearance as per instruction sheet.
Flush bodies and rinse valves.
Select valves and fit to nozzle body so that valve is ½ to ⅓ way in body.
Test pintle fit in spray hole for proper selection of valve and body. Lap valve or valve and body to fit. Test for taper by inserting valve into body stem end first.
Flush nozzle body and wash valves.
Hydraulic test for leakage with use of master assemblies to assure proper leakage rate.
Wash, flush with oil, test for leakage.
Inspect assemblies for leakage after machine lapping.
Hand lap seat tight, if necessary, and wash.
Inspect assemblies for leakage.
Wash valve & nozzle body, blow body & valve dry and place in dry tray. Dust valve pintle with talcum powder, tap off excess & insert valve ½ to ⅓ way into body.
Seat valve to set powder line on pintle. Grind profile on pintle.
Grind shoulder for lift, grind valve stem to length, grind chamfer.
Inspect for lift and stem dimensions as per instruction sheet.
Grind spray pintle to length.
Wash body and valve. Note: Clean valves will drop to the valve seat by their own weight.
Inspect for scratches and pintle length.
Wash, power flush with oil, check, correct if necessary, by lapping spray hole, lapping nozzle face, stoning nozzle face, stoning nozzle face or profile, etc. Wash before retesting.
Inspect nozzle for leakage. Inspect nozzle spray and spray angle.

MAGNETO CAM—An example of precision manufacture taken from the variety of operations on magnetos is found in the multi-lobed compensating cam. The contour is mirror-finished and is held concentric with the bore within 0.002 in. indicator reading. Similarly, each lobe must be parallel, axially, with the central bore within 0.002 in. The sequence of finishing operations is as follows:

OPERATION AND EQUIPMENT

Mill timing collar slot—#0 Sundstrand plain milling machine.
Finish bore and face timing collar seat and corners of seat and OD—Rivett lathe—Style 505.
Cut contour—#7 type Fellows H.S. gear shaper.
Drill oil hole & timing spot—Varimatic 2-spindle drill press.
Break 2 edges of slot and burr oil hole—Bench.
Wash and blow out—Washing stand.
Heat in cyanide for 3 hours at 1550 F and quench in oil—Cyaniding furnace & oil quenching tank.
Shot blast for 3 minutes—Wheelabrator.
Finish grind hole & face end—#5A Bryant chucking grinder.
Rough & finish grind contour—#5Y Bryant contour grinder.
Wash and blow out—Washing stand.
Magnaflux—Magnaflux type BF 202 inspection equipment.
Buff lobes—Hammond buffing machine, 2 Buffalo automatic buffing attachments.
Clean oil holes, wash and blow out; inspect.

(Turn to page 154, please)

Continental-Diamond
Engineered Non-Metallic Materials

The DILECTO punched part illustrated is a stator for an aircraft booster switch. It must of course have high dielectric properties. It must also be strong enough to support current carrying parts, and not deteriorate from vibration and impact shock. Its dielectric properties must be stable regardless of temperature, humidity or dryness. Finally it had to be made from a material that could be accurately punched. DILECTO met all these requirements with a wide margin of safety.

There are many grades of DILECTO. Each developed to meet specific electrical, mechanical, chemical or thermal problems. Special grades can be developed to meet unusual problems. DILECTO is also available in combination with Diamond Fibre to still further enlarge its sphere of usefulness. This C-D NON-metallic may be the answer to your "What Material?" problem, in your present and future products, whether used in the air, on land or sea.

KE-45

C-D PRODUCTS

The Plastics
DILECTO—A Laminated Phenolic.
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It may be noted in connection with these routings that the process for each part is liberally interspersed with inspection operations by the machine operator and by the inspectors. Owing to the relatively small bores and cavities associated with nozzle parts, machine operators and inspectors use toolmakers' microscopes and powerful light sources for examining the work.

Even this small sampling of parts machining will give the reader a better appreciation of the character of the precision work associated with diesel fuel injection equipment, and will emphasize the degree to which individual handling has been subdivided.

Since a word picture is inadequate in providing a visualization of the overall operations, we present a pictorial section consisting of views taken in various areas and departments. Several of the shop pictures give intimate close-ups of the operations on the component parts of fuel injection equipment and magnetos.

Effect of German Counter-Attack

(*Continued from page* 45)

ber is smaller than last year's output, total airframe weight will be considerably larger because of concentration on heavy bombers. An interesting note is that the more than 96,000 planes built by the United States in 1944 was only about 6000 under the 102,696 produced by aircraft factories in the United Kingdom between the start of the war in September, 1939, and last June—a period of 58 months or nearly five years.

Production of Trucks and Truck Tractors*

	LIGHT Under 9000 lb. G.V.W.		
	Civilian	Military	Total
November	......	19,765	19,765
Total—11 Months	1944	226,680	226,680

	MEDIUM 9000 to 15,999 lb. G.V.W.		
	Civilian	Military	Total
November	10,153	6,503	16,656
Total—11 Months 1944	78,423	82,054	160,477

	HEAVY 16,000 lb. and over, G.V.W.		
	Civilian	Military	Total
November	4,525	28,059	32,584
Total—11 Months 1944	24,658	260,897	285,555

	TOTAL—ALL WEIGHTS		
	Civilian	Military	Total
November	14,678	54,327	69,005
Total—11 Months 1944	102,081	569,631	672,712

*—Automotive Division, WPB Data Include jeeps, military ambulances and wheel-drive personnel carriers; half-tracks and armored cars are excluded.

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